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ABSTRACT

The manual presents a technology of instructional design and a model for developing and conducting efficient and cost effective Air Force instructional systems. Chapter 1 provides an overview of Instructional System Development (ISD). Chapters 2-6 each focus on a step of the process: analysis of system requirements; definition of education/training requirements; development of objectives; and tests; planning, developing, and validating instruction; and operation and evaluation of the instructional system. Chapter 7 summarizes the steps involved when applying ISD to knowledge and attitudes. In chapters 8 and 9, the ISD process is related specifically to Air Force flying training and technical training. Appendixes contain an explanation of terms, references, annotated bibliography, bibliography of technical materials, and instructions for completing the ISD status report. (EA)

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AF MANUAL 50-2
31 July 1975

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Training

INSTRUCTIONAL SYSTEM DEVELOPMENT

This manual directs the application of Instructional System Development principles and processes for the development and accomplishment of education and training programs throughout the United States Air Force. It presents a technology of instructional design and presents a model (guide) for developing and conducting efficient and cost effective instructional systems. Detailed procedures for implementing the concepts in this manual may be found in AFP 50-58. This manual applies to all education and training personnel who plan, develop, approve, administer, conduct, evaluate or manage Air Force instruction and its supporting materials.

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CHAPTER 1

Background and Introduction

1-1. Introduction. This manual is concerned with a process and a product. The process is Instructional System Development (ISD). The product resulting from the application of this process is an instructional system.

a. Essentially, ISD is a systematic procedure for assuring application of instructional technology to course planning and development. The planning concerns the need for instruction, the facilities, the instructional equipment, the instructional procedures, and the personnel (learners, instructors, instructional supervisors and managers, curriculum developers, media specialists, etc.).

b. The resulting instructional system is an integrated combination of resources (students, instructors, materials, equipment, and facilities), techniques, and procedures performing efficiently the functions required to achieve specified learning objectives. ISD should provide instruction specifically designed to teach people in minimum time and cost the knowledges and skills needed to perform a job.

c. The ISD process, a synthesis of ideas and procedures from several sources, is a relatively recent development. The management techniques were drawn from the planning systems devised to manage the development of complex weapon systems; the concepts of instructional design were drawn from programmed instruction; and developments in instructional hardware make feasible today some instructional tactics that were not practical a few years ago. The Air Force developed its first major instructional system in 1965, and, by now, has had substantial experience in applying the process described in this manual. The applications have involved a wide range of subjects, course lengths, and student populations for both new and existing courses. Because the application of ISD has consistently produced gains in the efficiency of instruction, Air Force policy directs use of the ISD process.

1-2. Air Force Policy:

a. Air Force policy regarding ISD is as follows:

(1) Apply ISD to produce all new instructional systems.

(2) Selectively apply ISD to existing instructional systems where economically feasible.

(3) The objective of ISD is to train to requirements. To achieve this, each instructional system must be designed to contain only the education/training appropriate to the individual. Education/training is to be measured on proficiency, not course length.

(4) The intent in applying ISD is to develop *quality* training at the least cost. This is not necessarily the same as "cheap" training. The distinction is most important.

b. To further the orderly application of ISD for each command's instructional programs, each command will prepare a programming plan or regulation that outlines the objectives and responsibilities for ISD. A copy of each plan/regulation will be forwarded to the Air Staff office of primary responsibility for ISD and be distributed as required.

c. Each major command submits a semiannual Instructional System Development Status Report, RCS: HAF-DPP (SA) 7303. The report covering the period 1 January through 30 June is due by 30 July, and the report for the 1 July through 31 December period is due by 30 January. The report is submitted to AF/DPPT. AF/DPPT will distribute the report to additional agencies as

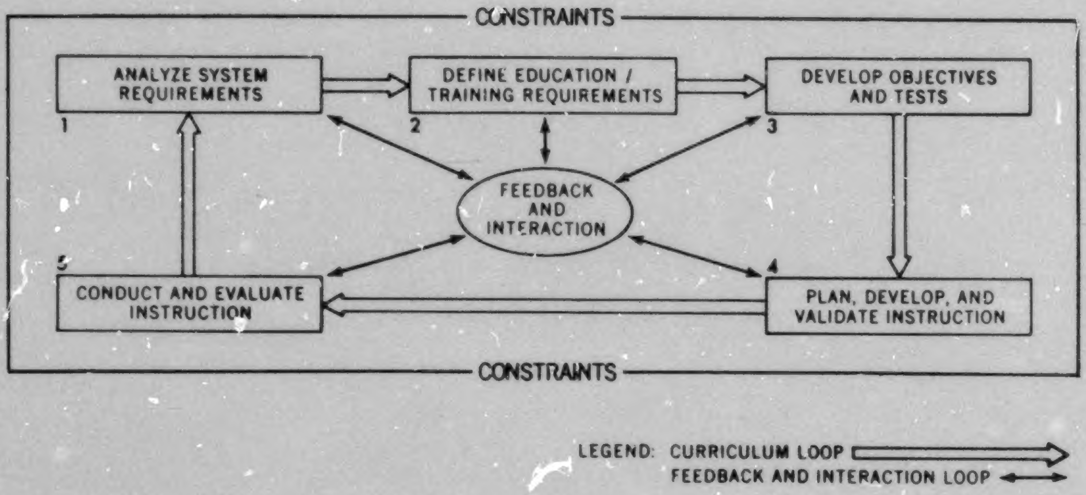
CONSTRAINTS
ANALYZE SYSTEM REQUIREMENTS
1
DEFINE EDUCATION / TRAINING REQUIREMENTS
2
DEVELOP OBJECTIVES AND TESTS
3
FEEDBACK AND INTERACTION
5
CONDUCT AND EVALUATE INSTRUCTION
4
PLAN, DEVELOP, AND VALIDATE INSTRUCTION
CONSTRAINTS
LEGEND: CURRICULUM LOOP
FEEDBACK AND INTERACTION LOOP

Figure 1-1. Model for Instructional System Development

required. Refer to attachment 5 for an outline of the data required.

1-3. Model for Instructional System Development:

a. The Air Force uses the five step ISD model illustrated in figure 1-1.[1] The process requires:

(1) determining precisely what are the human performance requirements on the job.

(2) determining the education/training requirements. This involves determining who is to do the job, and what education or training is necessary to enable them to do it in an acceptable way.

(3) defining these instructional needs as specific, behaviorally stated objectives and devising test items to determine if and when the students attain the objectives.

(4) designing instructional procedures and materials that will develop the skills and knowledges the students need to reach the objectives, and validating these procedures and materials to be sure they really do provide the needed instruction—no more, no less. Whatever portion of the instruction[2] does *not* equip the students to meet the objectives (and ultimately, to do the job) must be redesigned until it works.

(5) conducting and evaluating the instruction; and later, evaluating the students in terms of their ability to do the job.

b. The model illustrated in figure 1-1 prescribes an approach to the planning and development of instruction that is adaptive to all education and training programs. The model is applicable to revision and improvement of ongoing courses and instructional systems as well as to the design of new instructional systems. It is composed of logically interacting steps. The output of each step is intended to provide the input needed to accomplish a later step(s). As figure 1-1 shows, all parts of the model are interrelated. Changes which occur during one step of the model affect other steps. For example, evaluation of the graduates' ability to do the job might reveal that they cannot properly perform part of the job. This might be a result of improperly designed instruction—or it might be that the job has changed since the instruction was implemented. In the first instance, modification of the instruction is indicated. In the latter instance, a return to Step 1 and a partial or even complete analysis of job requirements might have to be reaccomplished.

c. Since there is feedback and interaction between steps of the model, sometimes portions of several steps can be accomplished simultaneously.

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[1] There are other models containing fewer or more steps. Despite this apparent difference, the process involved is basically the same.

[2] In this manual, *instruction* can be read as *education* or *training*.

d. The application of the ISD process may require compromises. Limited funds frequently rule out desirable options when selecting training media. Limited time available to develop the instructional system may necessitate a less than thorough analysis of system requirements, or using a smaller than desirable population for validation. These constraints must be considered in the design of the system. Of course, the goal is to devise an instructional system that includes the best possible combination of alternatives, where "best" is defined as quality training in the most cost-effective way available.

e. The following paragraphs provide a brief overview of the *steps of the model* for ISD.

(1) *Analyze system requirements (Step 1).* Before developing instruction, the instructional system designer must become familiar with every aspect of the operational system, job, or educational situation for which there is a *presumed* need for instruction. (In the beginning, there can only be the presumption of a need. Through application of the ISD process, a determination is made as to whether the presumption is correct and, if it is, precisely what instruction is needed.) Analyzing system requirements primarily involves data collection: data on the system; its purpose; man's functional responsibilities in the system; the subsystems and components that make up the system; support equipment or materials; and information on how the system operates, is maintained, or used. The product of this step is a definitive list of all job tasks, the equipment or materials involved with each task, the conditions under which the tasks must be performed, and the work quality requirements that must be met. For later use, data is also needed on frequency of performance of the tasks, safety requirements, criticality, complexity, and the difficulty of learning or teaching. Such determinations are made by observing the performance of personnel in the actual work environment, by interviewing or surveying supervisors and subject matter specialists, and by studying the applicable specialty description, training standard, related training documents, design documents, technical orders, and other documents which provide information on the system.

(2) *Define education training requirements (Step 2):*

(a) Based on job performance requirements, decisions are made concerning methods for acquiring qualified personnel. Instruction may not be required at all. Training is costly, and if not needed should not be given. The problem may not be lack of skills or knowledges, but rather motivation or working conditions. Hiring or reassigning people who can do the job may be more cost-effective than education or training. Perhaps the job could be redesigned; or job aids might be devised to reduce or eliminate training.

(b) Once it is decided that training is required, a determination is made of who will be trained. Then the tasks defined during Step 1 are analyzed and compared with the skills, knowledges, and abilities of the target population to determine what training is needed. Factors such as criticality, frequency of performance, complexity of the tasks, difficulty of learning, and time interval from training until initial performance must be considered. Other considerations are availability of time, availability of instructors, availability of equipment and facilities, costs, and availability of funding.

(3) *Develop objectives and tests (Step 3):*

(a) The instructional objectives are derived from the education or training requirements. These objectives should be specific and stated in terms of the expected behavior or performance. They should clearly identify what the student is expected to do, the conditions under which he is expected to do it, and the acceptable standard of performance. Objectives should be expressed in terms that will ensure that the instructional intent is communicated without ambiguity to all concerned.

(b) Identifying specific behavioral objectives is only a part of Step 3. The other part is designing test items to measure the attainment of these objectives. These are called criterion test items because they test against the criteria for successful performance that were identified in the objectives. On a criterion-referenced test, the students are rated on their ability to achieve the objectives. How others score on the test has no bearing on an individual's grade. (This is in contrast to the norm-referenced test in which the student is graded on how well he does in comparison with the other students.)

(c) The criterion test items are used in several different ways. As already noted, they are used to determine whether or not students have attained objectives. When administered to the student at the beginning of a course or unit of instruction, the test results can be used to determine which parts of the instruction he can safely bypass. When administered to a group of people who are similar to those for whom the instruction is to be designed (the target population), the test results can be used as an aid to course/instructional material design. For example, if most of the people can handle the test item(s) covering a particular objective, it may be that the objective should not be included in the course or the amount of instruction can be reduced.

(4) *Plan, develop, and validate instruction (Step 4).* The accomplishment of this step requires the careful planning of instruction to satisfy the objectives. This involves sequencing learning activities or exercises in an order that produces the required learning in the shortest time. It also involves the selection and planning of instructional methods, media, and equipment which most effectively support learning objectives. Accomplishment of these planning activities will provide the information needed to identify resource requirements. This step also involves the development and validation of instructional materials. The validation process ensures that the instructional materials and process enable the student to achieve the stated objectives. This determination is made through a series of tryouts with students in which the appropriate criterion test items serve as the measuring device. The instruction that does not validate (work) during the tryouts must be modified until it does.

(5) *Conduct and evaluate instruction (Step 5):*

(a) After the instruction has been developed and validated, it is ready to be implemented. Resources should be available. Instructors, supervisors, and course managers should be familiar with the instructional system materials and their roles and function in the system.

(b) Despite the constant efforts of everyone involved in its design, a newly implemented system seldom is completely successful. Evaluation must occur continuously to ensure that any weaknesses are corrected until the system works as intended. This evaluation involves both the conduct of the instruction and the performance on the job of the graduates. It provides the feedback necessary to maintain the quality and cost-effectiveness of an instructional system.

(c) Since ISD links training with actual job requirements, periodic change is to be expected in all instructional systems. The ISD process is a continuing cycle which allows training personnel to be responsive to these changes as they occur. When a need for change or updating of the instruction is indicated, the same ISD process is employed.

1-4. Application of the ISD Process:

a. In describing the ISD process, the emphasis has been on the component tasks. But there is also an accompanying logic and decision process. The process normally is initiated by the identification of a performance deficiency (new equipment coming into the inventory, production isn't up to standard, too many rejects, personal injuries, "they don't have the right attitude," etc.). After determining what the job involves (Step 1), the instructional system designer must determine whether the performance deficiency can be corrected by instruction. If it cannot, application of the ISD process is terminated. If instruction is the solution, the designer must determine what instruction is needed to enable the target population to meet the job requirements and how best to meet this need (Step 2). Although the tendency is to think immediately in terms of formal courses, the decision process requires the consideration first of less expensive alternatives (assigning or reassigning qualified personnel, use of performance aids, etc.). If assigning qualified personnel resolves the problem, that is as far as it is necessary to pursue the ISD process. If a formal course is determined to be appropriate, there are still several options: use an existing course, modify an existing course, or develop a new course. The balance of the ISD process (Steps 3, 4, and 5) involves designing instruction to meet the identified needs in a cost-effective manner.

b. All of the alternatives identified above represent application of the ISD process, though some alternatives will involve going through more steps of the model than others. Application of ISD will yield logical and supportable decisions as to whether the process should be continued, or when it should be discontinued.

c. It follows from what has been said that when one begins to apply the ISD process, one does not set out to "ISD a course" or courses. (Even if one were to begin by attempting to "apply ISD to a course," in the process, the job for which course graduates were destined would have to be considered. In so doing, a possible conclusion might be that the course is not needed.)[3] Whether or not there will be a valid need for one or more courses will be determined by the findings as one proceeds to apply the process. If this seemingly obvious concept is overlooked, much of the potential benefit from applying the process may be lost.

d.There has been reference to an instructional system designer, as though one person performed the complete ISD process. In some cases this may be what actually happens, but generally application of the ISD process involves the combined efforts of a number of people. These may include the subject matter, measurement, and media specialists, and even personnel outside the organization such as occupational survey specialists from the USAF Occupational Measurement Center. ISD teams may be created to handle some of the large, complex projects.

1-5. Summary:

a. The ISD process provides a methodolgy for the orderly development or revision of Air Force education and training programs. When conscientiously applied, the process ensures cost-effective instruction that produces graduates capable of successful job performance.

b. This chapter has provided an overview of the ISD process. Chapters 2 through 6 will each treat a step of this process in more detail.

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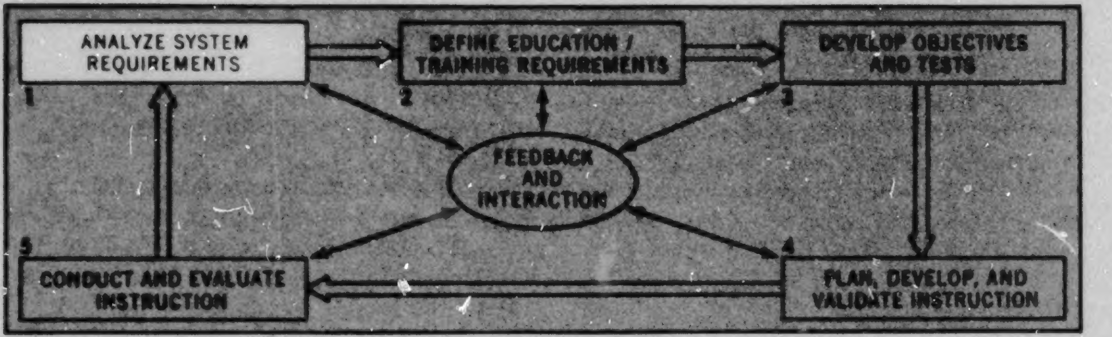
[3] During the transition period, as the Air Force implements this process in all of its course development and revision, ISD may be applied to a course as a result of a management decision rather than any known "performance deficiency."

CHAPTER 2

Analysis of System Requirements


ANALYZE SYSTEM REQUIREMENTS
1
DEFINE EDUCATION / TRAINING REQUIREMENTS
2
DEVELOP OBJECTIVES AND TESTS
3
FEEDBACK AND INTERACTION
4
PLAN, DEVELOP, AND VALIDATE INSTRUCTION
5
CONDUCT AND EVALUATE INSTRUCTION

2-1. Introduction. The first step in planning and developing an *instructional* system is the analysis of requirements of the *operational* system involved. This analysis is critical because all other steps in the ISD model depend on the information provided by the analysis. Jobs to be performed by qualified personnel are created by the requirements of these operational systems. The analysis of operational system requirements, or system analysis, is often thought to apply only to the design process for equipment oriented systems. Within the context of ISD, the application is much broader. System analysis applies to administrative, equipment, management, and support systems and subsystems, whether these systems are being developed, undergoing modification, or already in operation. The concept of system analysis is also applicable to Air Force specialties and career areas. This chapter describes the:

a. concept of operational system analysis;

b. sources of information for performing a system analysis;

c. definition of job performance requirements; and

d. sources and methods for collecting job requirements data.

2-2. Concept of Operational System Analysis:

a. A system analysis performed for ISD purposes will focus upon the human component of the system (1).[1] This analysis identifies the nature and scope of the human role in the system and the kinds of performance, or behavior, that will be required. For example, it must be determined whether man is to serve as an operator, a maintainer, a controller-manager or a combination of these. This determination cannot be made effectively without a comprehensive description of the individual characteristics of the system, career area, or Air Force specialty involved.

b. System analysis involves the collection of data about the system and its operation. Analysis of this data should produce a description of the system in terms of:

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[1] The number in parenthesis indicates a referenced source for the information. The references are identified in attachment 2.

(1) mission or purpose;

(2) functions or performance required to satisfy the mission;

(3) major subsystems and components used to structure the system;

(4) equipment or materials required to support the system;

(5) established concepts, policies, or procedures for system operation, maintenance, or utilization;

(6) effects of environmental factors on system operation and maintenance; and

(7) the human's functional responsibilities in the system, that is, the human-system interface.

c. The basis for planning and developing an instructional system is the tasks to be performed in operating, maintaining, controlling, or supporting the operational system. Therefore, the functional responsibilities of the human component of the system forms the starting point for identifying job performance requirements. Job performance requirements are described in terms of the job tasks, the conditions under which the tasks must be performed, and the work quality requirements that must be met. In later steps of the ISD process, these tasks will be analyzed to determine the specific behaviors (knowledges, skills, or attitudes) required for successful job accomplishment.

d. In addition to providing the information described in the preceding paragraphs, system analysis provides information needed to:

(1) determine whether or not a requirement to provide instruction exists;

(2) identify requirements for additional instructional systems; and

(3) determine the impact of changes in system mission, operation and maintenance concepts, or job performance requirements upon existing instructional systems.

2-3. Sources of Information for System Analysis. The following paragraphs provide a brief description of general sources of data or information which may be of value in establishing system requirements (more specific identification of data sources is provided in AFP 50-58, Volume 2, *Handbook for Designers of Instructional Systems, Task Analysis).*[2]

a. EQUIPMENT SYSTEM PLANNING AND ENGINEERING DATA:

(1) These data provide system requirements information for equipment oriented systems, such as aircraft, missiles, or detection and warning systems, which are being developed or are undergoing major modification. These data are valuable but sometimes are not available, are difficult to obtain or translate into Air Force terms, or are very costly to obtain.

(2) Planning data are documented under 57-, 80-, and 100-series Air Force regulations and AFR 800-2, *Program Management.* Among the major sources of planning data are:

(a) Required operational capability (ROC).

(b) Program management directive (PMD).

(c) Program management plan (PMP).

(d) Qualitative and quantitative personnel requirements inventory (QQPRI).

(e) Test plans (developed in accordance with AFR 80-14, *Test and Evaluation).*

(3) Engineering data are contained in a variety of documents, including:

(a) Engineering change proposal (ECP).

(b) Maintenance engineering analysis (MEA).

(c) Preliminary design review (PDR).

(d) Training equipment planning information (TEPI).

(e) Technical orders (TOs).

b. AIR FORCE AND COMMAND REGULATORY AND PROCEDURAL PUBLICATIONS:

(1) These publications are used in analyzing system requirements for career areas, Air Force specialties (AFSs), and equipment oriented systems already in operation. Regulatory and procedural publications describe systems, career areas, and specialties in terms of their subsystems, functions, capabilities, and use in attaining specific Air Force goals; identify system missions and establish the concepts and policies for their operation, maintenance, and use; and identify objectives and pro-

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[2] In order that the instructional system will not be outdated because of operation/equipment/policy changes in the period between the determination of system requirements and the implementation of the completed instructional system, information on probable changes should be included in the data gathered.

vide policy guidance on the implementation of specific Air Force programs. Personnel classification and assignment policies and specialty descriptions may be of value in analyzing the requirements of career areas of AFSs. In addition, reports and summaries of actions resulting from compliance with regulations and manuals are often of value in performing a system analysis. For example, reports obtained through the application of the Maintenance Management Program (AFM 66-1) permit comparative analysis of actual and planned human performance. The reports also identify the number and Air Force Specialty Code (AFSC) of the personnel performing a task and the frequency of performance.

(2) Procedural publications provide detailed instructions concerning the administration, operation, and maintenance of Air Force equipment, materiel, and programs. They describe program elements and system components and establish their relationship. They delineate human performance requirements and prescribe methods and procedures to be employed. Procedural publications can take several forms, such as: Air Force technical orders, job performance aids, military specifications and standards, governmental agency publications, and commercial publications. Some procedural information may also be obtained from Air Force and command manuals.

c. ADDITIONAL SOURCES OF INFORMATION:

(1) Education and training organizations have access to additional sources of information which improve their ability to identify and analyze system requirements. Among these sources are evaluation reports and feedback. Reports and feedback information are of the most value when used in conjunction with information obtained from the sources identified in the preceding paragraphs.

(2) Instructional evaluation reports summarize the results of evaluations conducted in accordance with Air Force directives (2) and/or command directives and supplements. Since satisfactory job performance is the criterion for instructional systems, evaluation reports reflect the adequacy of existing instruction in meeting the requirements of the operational system. Analysis of any reported deficiency or requests for additional instruction may lead to a more precise understanding of system requirements.

(3) Feedback on the effectiveness of the instructional and operational systems can be obtained through field trips, conferences, or correspondence between using organizations and the education/training activity. It can also be obtained through analysis of statistical reports such as incommission rates, maintenance management data (AFM 66-1), and accident rates. An additional source of feedback, for training of flight crewmembers, is the standardization-evaluation check. Feedback obtained by these means provides information on how a system is being operated, managed, or maintained. However, the field trip has a distinct advantage over the other methods of obtaining feedback. It permits analysis of the system in its operational environment, thus providing a more precise identification of system requirements and the related human performance implications.

2-4. Definition of Job Performance Requirments:

a. A vital aspect of instructional system planning and development is the accurate identification of the human tasks required to operate, maintain, control, or support the system. Instructional systems are effective only to the extent to which they qualify personnel for successful job performance. The job performance requirements are the tasks required of the human component of the system, the conditions under which these tasks must be performed, and the quality standards for acceptable performance. This definition of tasks, conditions, and performance standards provides a clear specification of what is to be done; why, when, and where it is to be done; and to what extent or degree of perfection it is to be done (3).

b. An important question to ask about the performance of any job is: Is it observable under real world conditions? While the training should equip the student to perform under real world conditions, it may not be possible to observe the performance of the task under real world conditions as a part of the training design process. One such type of situation occurs during development of new equipment or procedures when the task never has been performed and cannot be performed until installation of the new equipment or procedures. A related problem is that in which the training situation cannot be identical to the actual job performance conditions. An example of this would be training in performance of battlefield first aid; the training is not performed under the stress conditions of the battlefield. When the training situation cannot be identical to actual job performance, some approximation of job performance will be required.

c. Job performance requirements establish the basis upon which instruction is designed and also provide the frame of reference for evaluating the instruction (4). In addition, job performance requirements are used in determining: the number of personnel and AFSs required; the interaction required between system personnel; work location; and the equipment, tools, or materials required to accomplish the job. Analysis of this information makes possible the:

(1) derivation of qualitative and quantitative education or training requirements, including instructional resources implications;

(2) translation of duty and task data into instructional standards, learning objectives, and criterion tests; and

(3) continuous updating of job requirement data.

2-5. Sources and Methods for Collecting Job Requirements Data:

a. FOR NEW WEAPON/SUPPORT SYSTEMS:

(1) Systems managed under AFR 800-2 permit the acquistion of contractor-prepared data[3] to supplement information already available from within the Air Force. Some of these data concern planned use of the new equipment, some provide engineering data, some identify human performance requirements, and some provide results of tests conducted under AFR 80-14.

(2) The various components of a complex weapon/support system are usually not in the same stage of development at the same time. Thus, while there may be much information available on some subsystems of the weapon/support system, there may be other subsystems developing more slowly for which very little information is available. This situation presents a problem for the instructional system designer since he may have to make instructional planning decisions before all of the desired information is available. Such situations have existed in the past, and will probably arise in the future. ISD does not cause nor can it prevent this. But, to the extent that data have been gathered and analyzed in applying the ISD process at any given time, the instructional system designer has a more solid basis for making instructional planning decisions. As the weapon/support system develops and more of the design becomes firm, more information becomes available which can be used to update the ISD documentation in anticipation of the next opportunity to update instructional planning decisions.

(3) Another special problem in planning for a new weapon/support system is the need to plan concurrently for several versions of the training program. As a new weapon/support system is developed, it progresses through several stages, such as early testing and evaluation of prototypes, implementation of the production model, and routine support once the equipment becomes operational. Each stage may require training support. However, the training support needed probably will be somewhat different for each stage. There will be modifications in the hardware, and differences in the skill and experience of the people to be trained and the number requiring training. These differences will alter the training requirements. Concurrent planning of all this training (to the extent of determining training requirements, making decisions about methods for acquiring qualified personnel, defining the instructional objectives, and making a preliminary identification of resource requirements) is necessary to assure minimal training equipment costs and fullest use of the training equipment that is purchased.

b. FOR NEW TRAINING PROGRAMS OTHER THAN WEAPON/SUPPORT SYSTEMS. There are some system development and modification programs which do not employ system management procedures. Such systems may be either hardware or nonhardware oriented. In these instances, job performance requirements information in the form of published data is usually not readily available. Nevertheless, information concerning the work to be done and the nature of the work is *essential* to ISD. Obtaining job requirements information for such systems usually involves extensive research of engineering data and/or procedural publications. In addition to conducting research, it is often necessary to consult with the designers, engineers, and technicians who planned and developed the system. Every effort must be made to ensure the identification and documentation of job requirements data.

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[3] Data are procured in accordance with procedures outlined in AFR 310-1, *Management of Contractor Data*.

c. FOR REVISION OF EXISTING INSTRUCTIONAL PROGRAMS:

(1) The best source of information concerning job performance requirements for systems and career areas already in the operational inventory is the experienced person on the job. For professional military education, the person on the job may be the only source of information for determining curriculum requirements.

(2) Several methods are normally available for use in gathering the information needed to develop an inventory of the job tasks. They are described in the following paragraphs.

(a) Occupational Survey:

_1_ The occupational survey is the Air Force procedure for the identification of the duties and tasks which comprise one or more shredouts, prefixes, specialties, career field ladders, or utilization fields; and for the collection, collation, and analysis of information concerning such duties and tasks. Through the use of job inventories, occupational surveys obtain, from a representative sample of job incumbents, background information about them and specific data concerning the duties and tasks they actually perform. This information is tabulated and computer analyzed with the results prepared in the form of an occupational survey report. Data are reported in terms of percent performing tasks; relative time spent on tasks; and relative difficulty of tasks.

_2_ Occupational surveys for the Air Force are conducted by the USAF Occupational Measurement Center, Lackland AFB, Texas. Detailed information concerning procedures for requesting surveys to be conducted, and for obtaining existing survey reports, are contained in AFM 35-2 (5). (A sample portion of an occupational survey is included in chapter 9.)

(b) Questionnaire. The questionnaire is a method of obtaining job requirements information by mail survey.[4] It requests the job incumbent to provide certain background information and describe the job in his own words. When describing his job, the individual is asked to identify the duties and tasks he actually performs and to list the materials, tools, and/or equipment used. Incumbents are requested to work independently when completing the questionnaire. However, supervisors may be asked to verify responses before the questionnaire is returned to the originator. This procedure is designed to add comprehensiveness, objectivity, and validity to the information presented. Perhaps the chief economic advantages of this survey method are that no structured forms are used, and the mail can be used as the means of communication. A disadvantage is the difficulty in correlating the relatively unstructured, handwritten information. Another disadvantage is that the questionnaire method places a heavy demand on recall by those completing it. Incomplete forms increase the possibility of sampling errors. A well-designed questionnaire can minimize these disadvantages. Because know-how is needed to produce such a questionnaire, anyone planning to prepare a questionnaire should first obtain guidance on how to do it. (Additional guidance on the use of questionnaires is provided in chapter 6.)

(c) Checklists:

_1_ This survey method differs from the questionnaire method in that the checklist contains a listing of duties and tasks believed to describe the specialty or a postion within a specialty. The duties and tasks listed are based upon information obtained from specialty descriptions, instructional standards, job proficiency guides, and procedural or technical publications. In this type of survey, the individual is asked to identify, usually by means of a (√), the duties and tasks he performs. The results of the survey are compiled to form an updated duty/task list for the specialty or position. The use of the checklist makes possible group administration to large samples of incumbents, thus making job requirements data available rapidly and economically from widely representative populations. The responses to the checklist are adaptable to machine tabulation and the application of statistical analysis techniques.

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[4] If a survey of job incumbents is to be accomplished by mailed questionnaire or checklist, the questionnaire or checklist must be assigned a survey control number (SCN) by AF/DPP (see AFR 178-9, *The Air Force Military Survey Program*).

_2_ There are a number of problems inherent in the checklist method of conducting surveys. One is the difficulty of constructing checklist items which clearly communicate to the incumbent the exact nature of the duty and task assignments. Another is the ineffectiveness of the checklist for obtaining information relative to the sequence of task performance or the relationship among tasks. There also is a possibility that the checklist may not include all of the duties and tasks.

(d) Individual Interview. In using this method for collecting job requirements data, a number of representative workers are selected for interview. Those selected are interviewed concerning the duties and tasks they perform. Interviews are conducted on an individual basis, usually away from the work situation, and the information obtained is recorded on standardized forms. When all the interviews are completed the information is consolidated into a single job performance requirements listing. One of the advantages of the individual interview method is that it usually yields a better quality of information than the questionnaire or the checklist. Among its disadvantages is the time required to conduct the interviews and compile job requirements data.

_1_ Interview procedures should be determined prior to conducting the interview, and should be as explicit and detailed as procedures used to obtain data using a questionnaire. Areas for consideration include establishing contact with job incumbents, establishing rapport, outlining purposes of the interview, structuring the outlining of job duties deciding the level of behavior to be identified, and determining when to terminate the interview. (Additional guidance on conducting interviews is provided in chapter 6.)

_2_ The interview method is especially valuable when used in conjunction with the previously mentioned checklist or questionnaire. When the questionnaire is based on numerous interviews and the results of the questionnaire are clarified by further interviews with subject matter specialists, a valid inventory of job tasks is the result.

(e) Observation Interviews:

_1_ This method is similar to the individual interview except that it takes place at the work site. While the worker performs his assigned duties and tasks, the person gathering the information asks questions about the work being done and records the information. As a result the information obtained should be more specific, more complete, and more accurate than that obtained by other methods. Disadvantages are the relative slowness in obtaining the data, and the interview inevitably interferes with operational activities. The observation interview is more appropriately used to identify the specific skills and teaching points involved in learning to perform a task, than for developing an inventory of job tasks.

_2_ A good job observation program will determine what the workers *do*. The questionnaire or interview will determine what they *say they do*. The latter data should be used with some caution because there is a tendency for workers to say they *do* what they think they *should do* (6).

d. FOR KNOWLEDGES AND ATTITUDES. This category applies primarily, but not solely, to academically oriented education courses and to programs for influencing attitudes. Many other programs also include cognitive (knowledges, perceptions, etc.) and affective (attitudes, feelings and emotions) objectives.

(1) *Goal analysis:*

(a) Knowledges and attitudes are in the mind. They cannot be observed directly. The problem, then, is that none of the techniques previously described (occupational survey, questionnaire, checklist, or interview) will reliably indicate the knowledges and attitudes necessary to perform the job. But there is a viable alternative: *goal analysis*. All educational programs are based on broadly stated goals. (A goal, as the term is used here, is a general statement of educational purpose.) For example, job supervisors may indicate that the worker must "appreciate the importance of ground safety in performing his job." This could become a goal for an instructional program. Before such a goal statement can be useful in the instructional design process, it must be translated into observable behaviors. The way this is done is to identify some observable behaviors that would be accepted by the supervisors as very likely indications that the worker does indeed have this appreciation (7). In other words, it is necessary to find *indicator behaviors* and use these as highly probable evidence that the nonobservable knowledges or attitudes exist. Some behaviors that might be accepted as indicators that the worker does "appreciate the importance of ground safety in performing his job" are:

1 Adheres to published safety procedures and regulations even when supervised.

2 Practices good housekeeping in his work area.

3 Reports safety hazards.

4 Cautions others about their unsafe practices.

5 Submits suggestions to improve safety.

(b) These indicator behaviors would then be treated as job performance requirements. (An application of goal analysis is illustrated in chapter 7.)

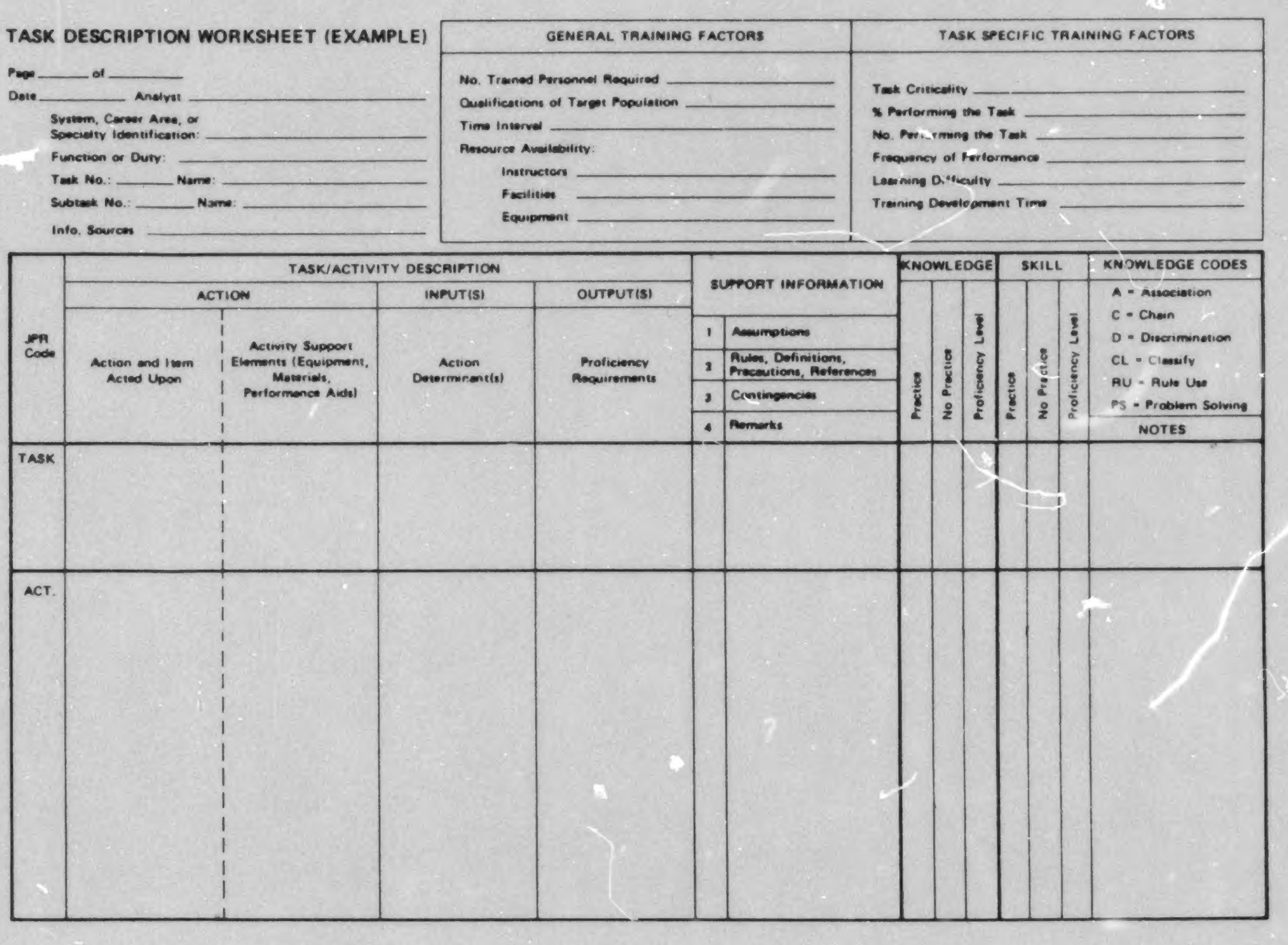
(2) *Content analysis.* Some courses are intended to teach a body of knowledge (for example, astrophysics, aptitude and achievement measurement, physiological psychology). The goal aim is to "cover the subject," rather than to equip the student to deal with any specific job applications, because the potential applications are so diverse and often unpredictable. In this case, too, the occupational surveys, questionnaires, checklists, or interviews described earlier in this chapter may not provide much useful guidance on what to include in the instruction. The alternative is to accept as a legitimate goal that the instruction should cover all of the subject matter identified in the title. If this is done, the subject matter experts become the authorities on what the instruction should include. What the subject matter experts provide would be the general instructional purpose statements (goals). These would serve as a substitute for the job performance requirement, and would become the starting point for instructional design. Analysis of these broad content statements would lead to the definition of objectives and instructional content (8).

e. RECORDING JOB PERFORMANCE REQUIREMENTS:

(1) A worksheet similar to the one shown in figure 2-1 is both adaptable and recommended for the purpose of recording task information. (Other worksheet formats may be used.) When completed, this worksheet becomes an inventory of the job performance requirements.

(2) Guidance for the preparation and use of this form is provided in AFP 50-58, Volume II, and an example of its use is shown in AFP 50-58, Volume I, *Handbook for Designers of Instructional Systems, Introduction.*

2-6. Summary. Actions relating to instructional system planning and development should be preceded by a thorough analysis of the requirements of the system, career area, or specialty to which its graduates will be assigned. Successful system analysis requires that all available sources of information be employed. The data obtained from the various sources should be compared to ensure accurate identification and an adequate understanding of requirements. System analysis must also provide the job performance requirements information needed to determine if instruction is required, or to develop or revise an instructional system. Instruction is effective only to the extent that it qualifies personnel for job performance. Therefore, an inventory of the duties and tasks to be performed by the human component of the system is the basis for instructional system development. Thorough analysis of system requirements will ensure that instructional systems are designed to meet operational or educational needs.



TASK DESCRIPTION WORKSHEET (EXAMPLE)

Page ______ of ________
Date __________ Analyst ____________________
System, Career Area, or Specialty Identification: ____________________
Function or Duty: ____________________
Task No.: ________ Name: ____________________
Subtask No.: ________ Name: ____________________
Info. Sources ____________________

GENERAL TRAINING FACTORS

No. Trained Personnel Required ____________
Qualifications of Target Population ____________
Time Interval ____________
Resource Availability:
Instructors ____________
Facilities ____________
Equipment ____________

TASK SPECIFIC TRAINING FACTORS

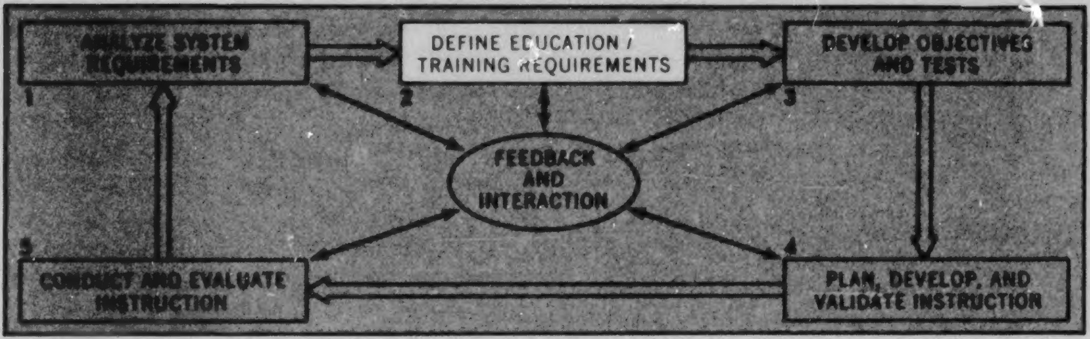
Task Criticality ____________
% Performing the Task ____________
No. Performing the Task ____________
Frequency of Performance ____________
Learning Difficulty ____________
Training Development Time ____________

JPR Code	TASK/ACTIVITY DESCRIPTION				SUPPORT INFORMATION		KNOWLEDGE			SKILL			KNOWLEDGE CODES
	ACTION		INPUT(S)	OUTPUT(S)	1	Assumptions	Practice	No Practice	Proficiency Level	Practice	No Practice	Proficiency Level	A = Association C = Chain D = Discrimination CL = Classify RU = Rule Use PS = Problem Solving
	Action and Item Acted Upon	Activity Support Elements (Equipment, Materials, Performance Aids)	Action Determinant(s)	Proficiency Requirements	2	Rules, Definitions, Precautions, References							
					3	Contingencies							
					4	Remarks							NOTES
TASK													
ACT.													

Figure 2-1. Example of a Worksheet for Recording Job Requirements

CHAPTER 3

Definition of Education Training Requirements


ANALYZE SYSTEM REQUIREMENTS
1
DEFINE EDUCATION / TRAINING REQUIREMENTS
2
DEVELOP OBJECTIVES AND TESTS
3
FEEDBACK AND INTERACTION
4
PLAN, DEVELOP, AND VALIDATE INSTRUCTION
5
CONDUCT AND EVALUATE INSTRUCTION

3-1. Introduction. The defining of education and training requirements represents the first major decision-making step in planning and developing an instructional system. The decisions to be made are: Is instruction necessary? If it is, who is to be taught? What instruction do they require? What method(s) should be used to provide the instruction? Preliminary decisions must also be made about identification of resources required to develop, implement, and support the instructional system. This chapter is concerned with the decision-making process as it relates to the:

a. determination, analysis, and documentation of education and training requirements;

b. methods for acquiring qualified personnel;

c. criteria and constraints affecting the selection of these methods; and

d. preliminary identification of resource requirements.

3-2. Determination, Analysis, and Documentation of Education/Training Requirements:

a. In Step 2 the qualitative and quantitative education/training requirements are determined. The process of making these determinations begins with an analysis of job performance requirements identified during Step 1 of the ISD model.

(1) The job performance requirements inventory that has been prepared must be compared with what is known about the people who will have to perform the job. This comparison should indicate whether or not an instructional requirement exists. If there is a valid requirement for instruction, the comparison will also reveal for which tasks/portions of tasks instruction will be required.

(2) If the workers are *capable* of meeting the job performance requirements, but do not do so, the working conditions should be carefully examined. There may be a number of possible causes: lack of motivation; human relations prob-

lems; pressures for overly high productivity; inefficiently organized work area; insufficient light; uncomfortable temperature; etc.

(3) If instruction is considered for workers already on the job, the analysis should identify those job performance requirements on which they show a performance deficiency. These will be the job performance requirements that will require instruction; instruction will not be needed on the others. The amount of the performance deficiency will determine the amount of training needed.

(4) If instruction is considered for workers who have no prior familiarity with the tasks, there still may be some job performance requirements that are so simple that instruction is not required.

(5) That portion of the job performance requirements inventory for which instruction will be required must be analyzed to identify the associated knowledges, skills, and their performance requirements. If a worksheet similar to that shown in chapter 2, figure 2-1, was used to record job performance requirements information, the same worksheet can be used to develop the *instructional* requirements information. AFP 50-58, Volume II, provides the information on how to do this.

b. The following paragraphs touch on some of the factors that should be considered in *determining the instructional requirements* to support the job performance requirements and how these requirements should be met. The factors that will be addressed are number performing the task, criticality of the task, frequency of performance, learning difficulty, time interval before initial performance, and prior experience. Although these factors are addressed separately, they must be considered collectively. Thus, a task that is rarely performed might still warrant instruction if it is a critical task (for example, mouth-to-mouth resuscitation).

(1) *Number performing the task.* If a task is performed by a majority of the job incumbents, it probably is an instructional requirement. A task performed by only a small number of job incumbents normally would be excluded. When the task is performed by about half of the incumbents, the decision to include or exclude training on it is very dependent on the other factors. Sometimes there is another alternative: defer the instruction until the individual is in the job situation, and then provide instruction for those who need it.

(2) *Criticality of the task.* Criticality refers to the relative importance of a task to mission success as compared to the importance of other tasks. In determining whether there is an instructional requirement relative to a given task, criticality is sometimes more important than the number performing. For example, initially it might seem that a task performed by a small number of job incumbents should be excluded as an instructional requirement. Yet, further analysis may reveal that an inability to perform that task in a precise manner, when the need arises, could have a serious impact on the organization's mission capability. The "best judgment" decision is made on the basis of both the number performing and the criticality of the task.

(3) *Frequency of performance.* In deciding what level of proficiency should be developed through formal instruction, the frequency of task performance is likely to have a direct bearing. For example, the more often a task is performed the greater the opportunity for the development of proficiency. This would suggest limited initial instruction followed by on-the-job training (OJT). In contrast, a task seldom performed but highly critical would likely require a high level of initial instruction.

(4) *Learning difficulty.* Some tasks are relatively easy to learn on the job and require little, if any, formal instruction. If analysis of the task reveals that it can be taught with little difficulty through OJT, the instructional requirement would be met by a combination of limited initial instruction followed by OJT. Conversely, a task difficult to teach on the job would require a high degree of formal instruction.

(5) *Time interval before initial performance.* If analysis indicates there will be a substantial time interval between completion of formal instruction and initial performance on the job, two decisions must be made:

(a) Should formal instruction be provided on the task(s), or should the instruction be deferred until the time when it will be needed? If, for example, certain electronic fundamentals are not required until the 5- or 7-skill level is attained, then it is questionable to include those fundamentals in a basic (3-skill level) course.

(b) If the decision is made to provide formal instruction on the task(s), how much repetition will be necessary to assure that the student retains the skill/knowledge involved until it is needed on the job?

These decisions have many significant implications including training costs and the proportionate distribution of training time and job productive time.

(6) *Prior experience.* Personnel selected for assignment within a specialty may possess some of the basic knowledges and skills needed for successful job performance. Criterion measures can be developed from an analysis of the task and knowledge statements derived from the job performance requirements. By administering survey tests based on the criterion measures to a representative sample of the target population, skills and knowledges already within the capabilities of the students can be identified. It would be uneconomical to build into instruction the teaching of knowledges or skills already possessed.

3-3. Methods for Acquiring Qualified Personnel. Another decision to be made during this step of the instructional system model concerns the selection of methods for acquiring personnel qualified to meet the job performance requirements. Depending upon the kind and degree of qualification needed, any one or a combination of techniques may be employed. The following paragraphs describe methods which may be used.

a. SELECTIVE PERSONNEL ASSIGNMENT. It may not be necessary to provide instruction to acquire personnel who possess the qualifications needed for job performance. Qualified personnel may be available as a result of system phaseout, or as a result of surpluses in allied career areas. For example, the Air Force phases out a computer system in favor of one of more advanced design and greater capability. The programmers assigned to the former system possess basic knowledges and skills which can be, and should be, utilized in the new system. In this example, instruction may or may not be required, or not as much may be needed. The job requirements of the Air Force are constantly changing; therefore, previously acquired knowledges and skills should be considered and utilized wherever possible. Another example of selective assignment is the recruitment of personnel who possess needed qualifications. Air Force requirements for certain technical specialties and professional personnel, such as doctors, lawyers, and engineers are met in this manner.

b. ON-THE-JOB TRAINING (OJT). On-the-job training is a systematic application of self-study and the craftsman-apprentice principle (9). Under this program, specialty knowledge is acquired by enrolling in and studying courses designed for career development,[1] while job proficiency is acquired by performing on the job under the supervision of a skilled professional or technician. This combination usually provides the qualifications needed after only a short period of experience. OJT is particularly suitable for developing job proficiency and is often used in conjunction with, or as a continuation of, instruction received through formal courses. OJT is frequently used as the method for retraining personnel from one career area (or specialty) to another (10). It also plays a major role in professional military education since most management training is accomplished through OJT. Therefore, OJT may be the most effective and economical method for satisfying education or training requirements.

c. FORMAL COURSES OF INSTRUCTION. The Air Force requires a wide variety of specialties composed of numerous combinations of knowledges and skills. Some jobs are highly complex and require long periods of instruction. Others are less complex and the instructional time required is correspondingly less. In some specialties emphasis is placed on knowledge, while in others the development of skill is more important. To develop the behaviors (knowledges, skills, and attitudes) needed for successful job performance, any one or a combination of the following alternatives may be used.

(1) *Existing courses.* Education or training requirements can often be satisfied through the use of existing courses that are available to the Air Force. These courses may be conducted by the Air Force, or provided to the Air Force by

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[1] Career Development Courses (CDCs) and/or courses prepared by the Extension Course Institute.

other governmental agencies, industry, or civilian educational institutions. (AFR 50-18, *Interservice Formal School Training*, requires a military service having a training requirement for which no training exists within that service to examine the feasibility of using existing courses within the other services before establishing a new course. (25)) Decisions relative to the suitability of these courses should be based on the requirements of the job(s) to be performed.

(2) *Revised courses.* When it has been determined that an instructional requirement cannot be adequately met by an existing course, revision of that course should be considered. However, the impact of the revision upon the original requirements for the course must be carefully studied. If the proposed changes do not detract from the original purpose, revision may be an effective method for meeting both the original and current requirements.

(3) *New courses.* Often the only practical method for satisfying education or training requirements is to develop a new course. This is largely due to the unique requirements imposed by the complexity and sophistication of new systems. In establishing new courses, decisions must be made concerning the most effective means for meeting instructional requirements. These decisions involve choosing from among the six types of training described in chapter 3 of AFM 50-5, *USAF Formal School Catalog*, Volume I, 1 September 1974, including contract special training (Type 1), ATC special resident training (Type 2), resident regular training (Type 3), and field training (Type 4).

d. HOME STUDY INSTRUCTIONAL PACKAGES:

(1) There are instructional situations where it is more practical to bring the instruction to the students than the students to the instruction. The *home study* approach is a proven idea, and recent developments in instructional technology have extended the possibilities of what can be included in such instructional packages. Slides with simple handviewers and audiotape cassettes make multimedia packages feasibly and usable almost anywhere. Programmed instructional techniques can make the instruction student-centered and individualized. Simple responder devices can provide prompt feedback to the student as he progresses through the instruction. Through application of the ISD process, instructional packages can be produced with confidence that they will accomplish what they are intended to.

(2) *Home study* instructional packages are especially useful:

(a) as short courses, for example, it becomes very expensive for the amount of instruction involved to bring students from all over the country to attend a one-day course;

(b) as refresher courses where the training is needed by many who are widely separated geographically, for example, an annual navigator refresher course;

(c) as preparatory instruction for those who need to develop or improve prerequisite skills, for example, an English grammar review for those scheduled to attend a course in which the ability to write studies and reports is essential; and

(d) for updating instruction to keep skilled persons abreast of new developments in their field, for example, instruction on new information about allergies and their treatment for practicing doctors.

e. JOB PEFORMANCE AIDS. In some situations a job performance aid or set of aids may provide all the instruction necessary, and avoid the need for formal instruction. Job performance aids can assume many forms. The plate on a gas heater that provides instruction on how to relight the heater is a simple job performance aid. Figure 3-1 shows an example of a performance aid for a maintenance task. Figure 3-2 is a performance aid in decision logic form.

3-4. Criteria and Constraints Affecting the Selection of Methods. The selection of cost-effective methods for acquiring qualified personnel is influenced by a number of factors. Chief among these is the job performance required. Several additional factors need to be considered. Some of these latter factors may impose constraints upon the selection of methods. The following paragraphs describe these considerations and show their interrelationship.[2]

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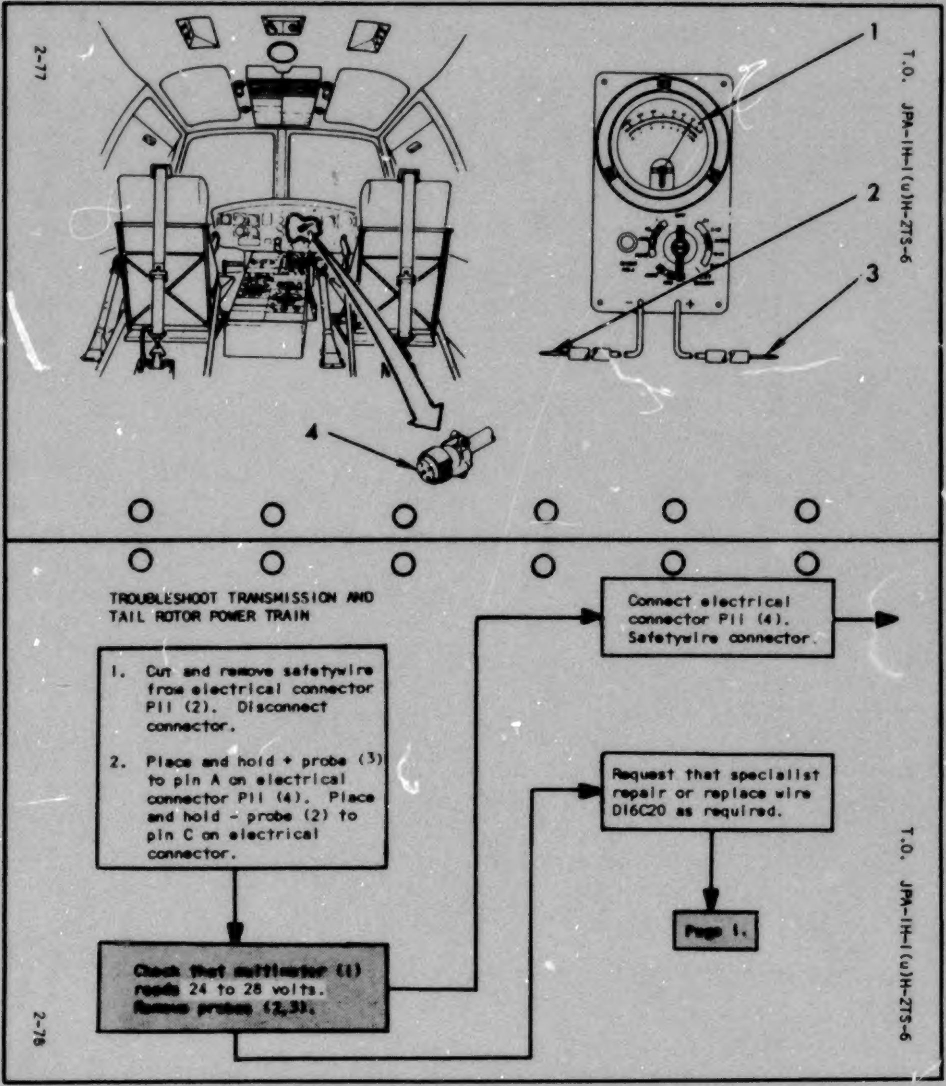
[2] The information presented is based on the premise that instruction is necessary to develop the qualifications needed.



TROUBLESHOOT TRANSMISSION AND TAIL ROTOR POWER TRAIN

1. Cut and remove safetywire from electrical connector P11 (2). Disconnect connector.
2. Place and hold + probe (3) to pin A on electrical connector P11 (4). Place and hold – probe (2) to pin C on electrical connector.

Check that multimeter (1) reads 24 to 28 volts. Remove probes (2,3).

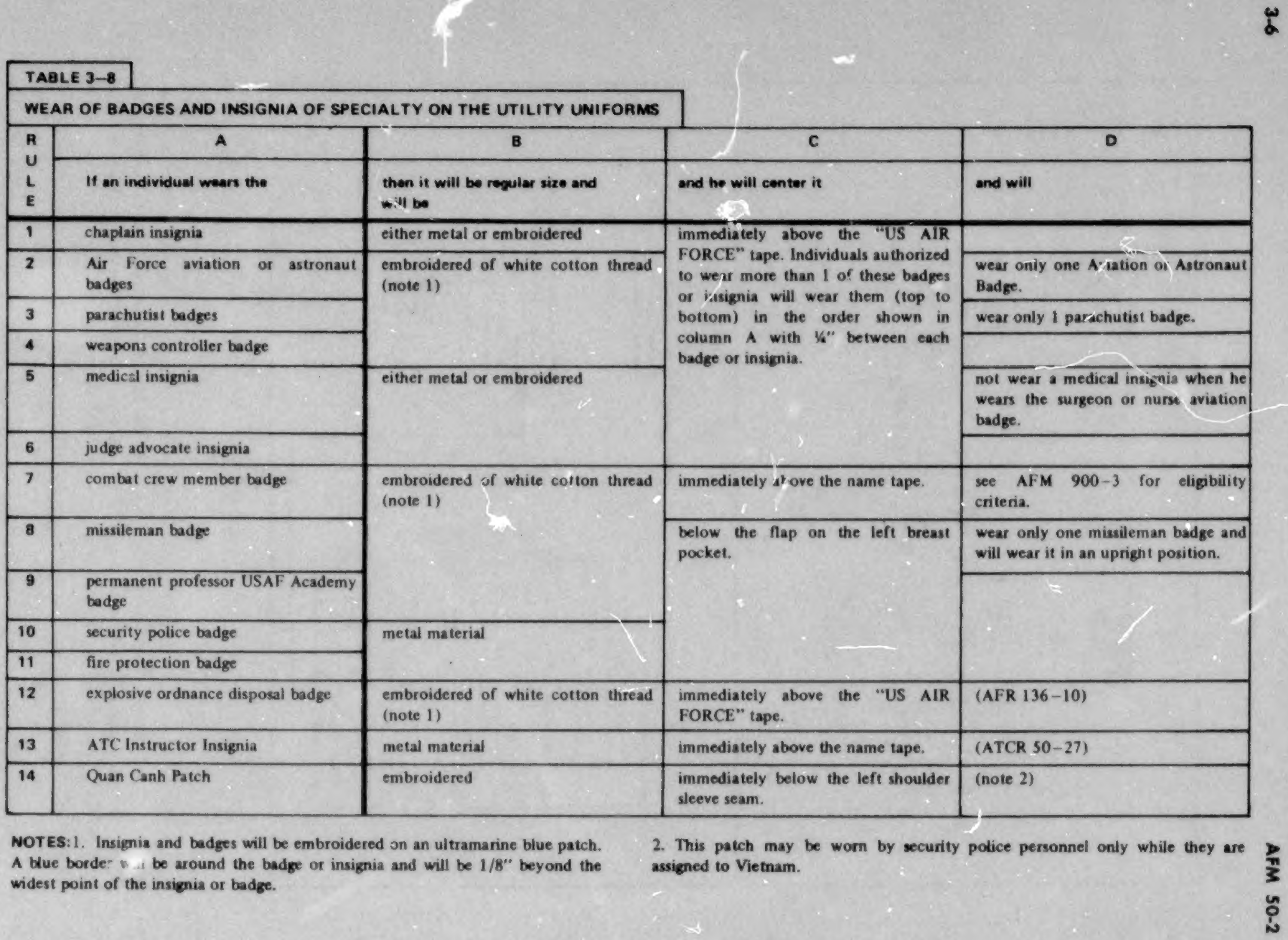
Connect electrical connector P11 (4). Safetywire connector.

Request that specialist repair or replace wire D16C20 as required.

Page 1.

Figure 3-1. Example of a Job Performance Aid

a. Trained Personnel Requirements (TPR). This consideration is concerned with the number of qualified personnel required. The TPR reflects time-phased requirements for the various AFSs needed to accomplish the overall Air Force mission. Based on TPR information, instructional system designers must evaluate the various alternatives for acquiring qualified personnel. Among the alternatives to be considered are the relative suitability of: selective personnel assignment, OJT, the use of existing resident or field training courses, and the development of new resident or field training courses. Generally, a requirement for large numbers of personnel to be qualified over a long period of time can best be satisfied by the use of resident courses.



3-6

AFM 50-2

TABLE 3–8

WEAR OF BADGES AND INSIGNIA OF SPECIALTY ON THE UTILITY UNIFORMS

RULE	A	B	C	D
	If an individual wears the	then it will be regular size and will be	and he will center it	and will
1	chaplain insignia	either metal or embroidered	immediately above the "US AIR FORCE" tape. Individuals authorized to wear more than 1 of these badges or insignia will wear them (top to bottom) in the order shown in column A with ¼" between each badge or insignia.	
2	Air Force aviation or astronaut badges	embroidered of white cotton thread (note 1)		wear only one Aviation or Astronaut Badge.
3	parachutist badges			wear only 1 parachutist badge.
4	weapons controller badge			
5	medical insignia	either metal or embroidered		not wear a medical insignia when he wears the surgeon or nurse aviation badge.
6	judge advocate insignia			
7	combat crew member badge	embroidered of white cotton thread (note 1)	immediately above the name tape.	see AFM 900–3 for eligibility criteria.
8	missileman badge		below the flap on the left breast pocket.	wear only one missileman badge and will wear it in an upright position.
9	permanent professor USAF Academy badge			
10	security police badge	metal material		
11	fire protection badge			
12	explosive ordnance disposal badge	embroidered of white cotton thread (note 1)	immediately above the "US AIR FORCE" tape.	(AFR 136–10)
13	ATC Instructor Insignia	metal material	immediately above the name tape.	(ATCR 50–27)
14	Quan Canh Patch	embroidered	immediately below the left shoulder sleeve seam.	(note 2)

NOTES: 1. Insignia and badges will be embroidered on an ultramarine blue patch. A blue border will be around the badge or insignia and will be 1/8" beyond the widest point of the insignia or badge.

2. This patch may be worn by security police personnel only while they are assigned to Vietnam.

Figure 3-2. A Job Performance Aid in the Form of a Decision Logic Chart

b. Target Population. This term refers to the prospective personnel input to the system, career area, or specialty. In selecting methods, the suitability of existing courses and the practicality of revising such courses, in lieu of developing new ones, must be assessed. One basis for making this assessment is information obtained from aptitude tests such as the Airmen Qualifying Examination (AQE) or other tests developed by the Air Force Systems Command's Human Resources Laboratory, Personnel Research Division. Results of these tests are useful in determining the range of aptitudes, prior experiences, knowledges, or skills possessed by the target population. This information has an impact on course length and content, equipment and facility requirements, and time needed for instruction.

c. Task Criticality and Learning Difficulty:

(1) The criticality of a task is determined by two considerations: whether the task is performed under emergency conditions; and the consequences of inadequate performance.

(2) Learning difficulty is generally related to the complexity of the task and to the types of knowledge and performance is shown in table [illegible]-1. This list is arranged in order of increasing difficulty. (This table is discussed in AFP 50-58, Volume II.) Complex tasks usually involve application of several of these types of knowledge and performance.

(3) Knowing the types of knowledge/performance involved in performing a task helps the instructional system designer determine the best method of instruction. For example, resident courses are usually best suited for teaching principles (rule using) and developing motor skills (motor chaining). This is because such courses provide the equipment and other resources needed to teach principles and procedures, and provide sufficient time for the development of skills.

d. Availability of Time. This factor refers to the time available to develop and implement instruction. A short leadtime may rule out some of the possible options in the design of instruction. It may also be appropriate to consider purchasing instruction (from the manufacturer, a university, or other appropriate agency) or hiring trained personnel to do the job until there is time to develop an Air Force-prepared program or the instructional requirement ceases to exist (12). If instruction is to be purchased, whatever information has been gathered relating to Steps 1 and 2 of the ISD process will provide useful guidance in specifying what instruction to purchase.

e. Availability of Qualified Instructors:

(1) This consideration is concerned with the number and qualifications of personnel needed to develop and conduct instruction. If instructors are not available, a period of 9 to 12 months is generally needed to obtain the personnel and qualify them as instructors. If the prospective instructor must also become technically qualified in the subject area or specialty to be taught, the time required to obtain a proficient instructor is increased. In addition, consideration must also be given to the availability of personnel needed to accomplish detailed planning and development of the instructional system.

(2) Should an instructional program require increased manpower authorizations for its operation and maintenance, these resources must be programmed and budgeted well in advance of the time additional instructors or ISD personnel are required.

f. Availability of Equipment and Facilities. Decisions relative to the selection of methods may be influenced by requirements for, and the availability of, equipment and facilities. Although a detailed instructional design has not been accomplished, requirements for facilities and major items of equipment can usually be identified. The acquisition of these resources usually requires leadtime for development and installation. Therefore, consideration should be given to the practicability of modifying existing equipment and facilities.

g. Availability of Information. The development or revision of courses may be affected by the availability of data. When related to time and cost, this consideration may become a determining factor in selecting methods.

h. Programmed Student Load. This is the number of students that must be in a course at any one time to satisfy the requirements for trained personnel. Student load has a direct bearing on the requirement for equipment, facilities, and qualified instructor personnel. For example, when considering the use of an existing course, thought must be given to that course's capability to handle an increased student load. If it is already operating at maximum capacity, an increased student load will create a need for additional instructors, equipment, or facilities.

i. COSTS:

(1) This factor is presented last since virtually all the other considerations have an impact upon it. Each of the possible methods for acquiring qualified personnel must be evaluated in terms of its economy, effectiveness, and timeliness for meeting requirements. The cost factor is particularly important when considering the advantages and/or disadvantages of bringing the student to the instructional activity as opposed to taking the instruction to the student.

(2) As important a consideration as cost is, it must always be considered in context with quality of training. The goal must always be to develop and to provide quality training at least possible cost.

3-5. Preliminary Identification of Resource Requirements. The selection of methods for acquiring qualified personnel, discussed previously, is influenced by a number of considerations and constraints. Among these are factors relating to requirements for equipment, facilities, and personnel. The success of an instructional system often depends on the adequacy and timeliness of these resources. The total resources needed cannot be determined until activities required in Steps 3 and 4 of the instructional system model have been accomplished.[3] However, leadtime requirements may make it necessary to identify some of these resources prior to finalizing these steps.

a. EQUIPMENT. It is usually necessary to identify the major items of system-peculiar or unique equipment early in the ISD process. Most of this equipment will undergo a development cycle similar to that of a weapon system. That is, it has to be designed, produced, installed, and tested prior to course implementation. Failure to identify these items of equipment until course development nears completion will have a detrimental effect on the instructional system's ability to provide qualified personnel in a timely manner. However, equipment should not be procured until the instructional objectives have been tentatively developed to be sure that what is obtained supports a valid instructional requirement.

b. FACILITY. Facility requirements, like those for major items of equipment, must be identified as early as possible. Early identification is necessary because of the time required to obtain funds and complete the construction or modification project.

c. PERSONNEL:

(1) Though the leadtime may not be as great as for facilities and equipment, early identification of personnel requirements is also necessary. Of primary concern are the personnel needed to accomplish instructional system design. Additionally, in planning for initial instructor requirements, provision should be made for sufficient time to train the instructors. This is particularly important if instruction is being developed for new specialties or systems and instructors must become technically qualified.

(2) There may also be a need to identify support personnel such as typists, illustrators, photographers, and hardware fabricators.

(3) The budgeting of additional or revised manpower authorizations must be accomplished well in advance of actual personnel requirements.

d. FUNDING. The identification of requirements for any of the above resources will usually have an impact on financial requirements. Budgets have to be prepared, or revised, and funds appropriated to allow for the procurement of equipment and the construction or modification of facilities. The establishment of personnel requirements will also affect funding requirements for payroll support. In addition, it may be necessary to provide funding for travel if the instruction is to be conducted by mobile training teams (12) or if students are to attend courses in a temporary duty (TDY) status. Since budgets are normally submitted and approved long before money is actually spent, the instructional system designer must exercise great judgment in determining, as precisely as possible, what resources will be required. Careful planning will help to assure resources when they are needed—not too early or too late.

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[3] Step 3, Develop Objectives and Tests; Step 4, Plan, Develop, and Validate Instruction.

3-6. Instructional Standards:

a. PURPOSE AND SCOPE OF INSTRUCTIONAL STANDARDS:

(1) At this stage, the job performance requirements have been established and the instructional requirements determined. If the instructional requirements are to be met by formal course, CDC, and/or OJT, the instruction to be provided should be documented in an instructional standard, using the data from the worksheet shown in figure 2-1, or equivalent. If an instructional standard already exists, it's validity, or need for revision, should be determined by checking it against the instructional requirements.

(2) Examples of instructional standards currently in use are the Specialty Training Standard (STS) and the Course Training Standard (CTS). The STS is the controlling document required for airman basic resident, airman advanced resident, airman lateral resident, and CDCs. CTSs are used for airman supplementary, field, special training, and officer courses.[4]

(3) These instructional standards are specialized publications used to standardize and control instruction. They are also the means for coordination between those responsible for instruction and the organizations for whom instruction is conducted. Such coordination helps to ensure that the instruction is designed to meet the using organization's needs. Instructional standards list, by means of task and knowledge statements, the instruction required to qualify personnel for job performance. These listings constitute the quantitative requirements to be satisfied by the instructional system. Instructional standards are also qualitative. They specify the degree or level of proficiency to be developed for each task or knowledge. Some instructional standards also show the method(s) of instruction to be employed and the allocation of tasks and knowledges to formal courses or OJT.

b. PREPARATION OF INSTRUCTIONAL STANDARDS:

(1) It is possible to develop a CTS that is quite descriptive of the planned instruction if behavioral statements are used instead of phrases augmented by a code key (see the example in chapter 8). The STS describes not a single course but a whole career ladder with several skill levels and possibly several courses. This basic complexity coupled with use of a code key (which inevitably is open to some degree of interpretation), and the fact that STSs serve multiple purposes, make the usual STS unsuitable for use in *detailed* planning of instruction. Such STSs only reflect in summary form the instructional intent.

(2) The tasks, knowledges, and attitudes to list in the instructional standard can be drawn from the instructional requirements that have been established. For the STS, the factors discussed earlier in this chapter in connection with the determination of instructional requirements will determine the proficiency codes shown in the different skill level and course columns of the instructional standard (see chapter 9).

3-7. Summary:

a. The definition of education or training requirements is the first major decision-making step in ISD. These requirements are determined by analysis of the job performance requirements and information about the people who are to perform the jobs. A determination must also be made concerning cost-effective methods for acquiring qualified personnel. A decision to employ a formal course of instruction usually necessitates the preliminary identification of resource requirements. These resources include the major items of system-peculiar or unique equipment, the facilities to be constructed or modified, the manpower authorizations required (to include possible trade-offs from current programs) and the personnel needed to develop and place the instructional system into operation. Since each of these resources represents costs, financial requirements must also be identified and funds budgeted.

b. Also during this step of the ISD process, instructional standards are developed. These standards specify the behaviors (knowledges, skills, and attitudes) and the degree or level of proficiency needed for successful job performance and course completion.

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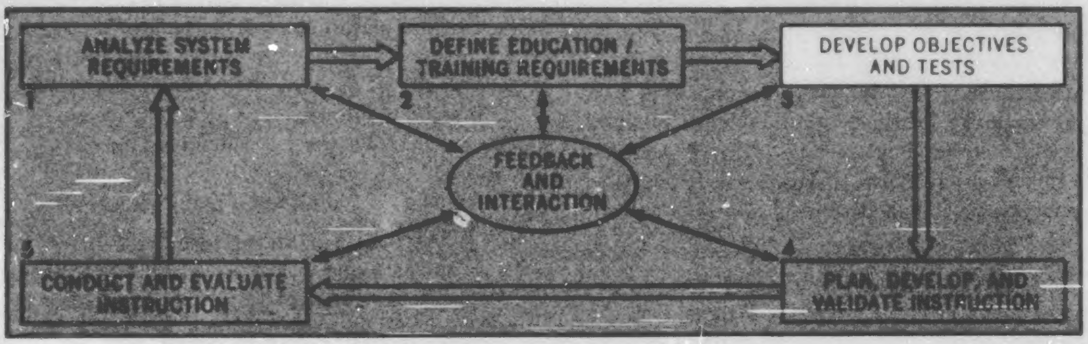
[4] The preparation and use of the STS is prescribed by AFR 8-13, *Air Force Specialty Training Standards*. Each major command that uses CTSs has its own prescriptive regulation. The principal difference between CTSs and STSs is that CTSs list tasks and knowledges attainable within the course, whereas STSs list the qualitative and quantitative requirements for each level of skill within a specialty. Chapters 8 and 9 of this manual contain extracts from CTSs. Chapter 9 contains an extract from an STS, and so does Volume II of AFP 50-58.

CHAPTER 4

Development of Objectives and Tests


ANALYZE SYSTEM REQUIREMENTS
1
DEFINE EDUCATION / TRAINING REQUIREMENTS
2
DEVELOP OBJECTIVES AND TESTS
3
FEEDBACK AND INTERACTION
4
PLAN, DEVELOP, AND VALIDATE INSTRUCTION
5
CONDUCT AND EVALUATE INSTRUCTION

4-1. Introduction. In chapters 2 and 3, the products of Steps 1 and 2 were described. In Step 3, these products are used to develop:

a. objectives, through an analysis of education/training requirements;

b. criterion-referenced tests, which evaluate the student's attainment of the objectives;

c. diagnostic tests, which measure the student's mastery of the supporting knowledges and skills required to achieve the objectives; and

d. survey tests, which determine the knowledges and skills already possessed by the intended student population.

4-2. Development of Objectives:

a. OBJECTIVES AND LEARNING:

(1) Learning a physical skill requires actual experience in performing that skill. Mental habits are also learned through practice. Even attitudes are developed or modified as an individual reacts emotionally to a stimulus. It is implicit in these statements that for learning to take place, the *learner* must be actively involved in the learning situation.[1]

(2) Learning cannot be directly observed. But it can be inferred on the basis of observations of how the learner behaves after instruction in comparison with how he behaved before instruction. The person who has learned something is somehow different from the person he was before learning took place. His *behavior* is different. Since instruction should shape the desired behavior, the objectives of that instruction should describe the desired behavior. Also, observable behavior is what must be used to judge whether or not the instructional objectives have been achieved.

(3) An objective is a precise statement that answers the question: What must the student *do* to show he has learned what he was expected to learn? It specifies a *behavior* to be exhibited. For the statement to be understood in the same way by all who work with it, it must also include the

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[1] See AFM 50-62, *Principles and Techniques of Instruction*, chapter 2, 1 April 1974 for a discussion of the psychology of learning.

minimum *standard* of performance or proficiency expected, and the *conditions* under which the behavior is to be exhibited.

b. HIERARCHY OF OBJECTIVES. Objectives can be specified at several levels. Objectives can be specified for: the basic skills and knowledges; the more complex skills which represent combinations of these basics; and the application of these skills and knowledges in actual job situations. Many terms have been used to describe the various levels of objectives (criterion, terminal, primary, enabling, supporting, secondary, etc.). In this manual, the terms *criterion objective* and *subobjective* will be used only where it is necessary to show a hierarchical relationship between objectives (as in the example in figure 4-1). Whatever the descriptive term that might be used (criterion, terminal, primary, etc.), basically they are all objectives and should describe *behavior, conditions,* and *standards*.

c. CHARACTERISTICS OF OBJECTIVES:

(1) *Behavior performance*. An instructor cannot read the mind of the student to verify the extent of the student's understanding. It is only through some overt (observable) activity on the part of the student that the extent of his knowledge or skill can be measured. The statement that a student will "understand Ohm's law" is an example of an obscure objective. One instructor may feel that if the student recites the law it indicates understanding. Another may say that the student should explain the law. A third may contend that the only way the student can satisfy this objective is for him to use the formula to solve problems in electrical circuitry. A more precise objective could read that the student will "use Ohm's law to determine applied voltage when amperage and circuit resistance are known." An objective, so stated, lets the student, instructor, supervisor, measurement personnel, writers, and course managers know exactly what the student is to learn and what behavior the student should exhibit to demonstrate satisfactory achievement. Use of *action verbs* reduces ambiguity and promotes the understanding of instructional intent.

(2) *Conditions*. A properly prepared objective also clearly states the limits and/or conditions within which the student will be expected to perform. This portion of the objective describes the important aspects of the environment in which the behavior will be performed. What does the student have to work with? Must he select the correct tools? Is he allowed to use notes he has taken on the subject? Are technical orders or checklists available to him for guidance? What information will be provided as a starting point? These are typical questions which must be considered before an objective can be put into final form.

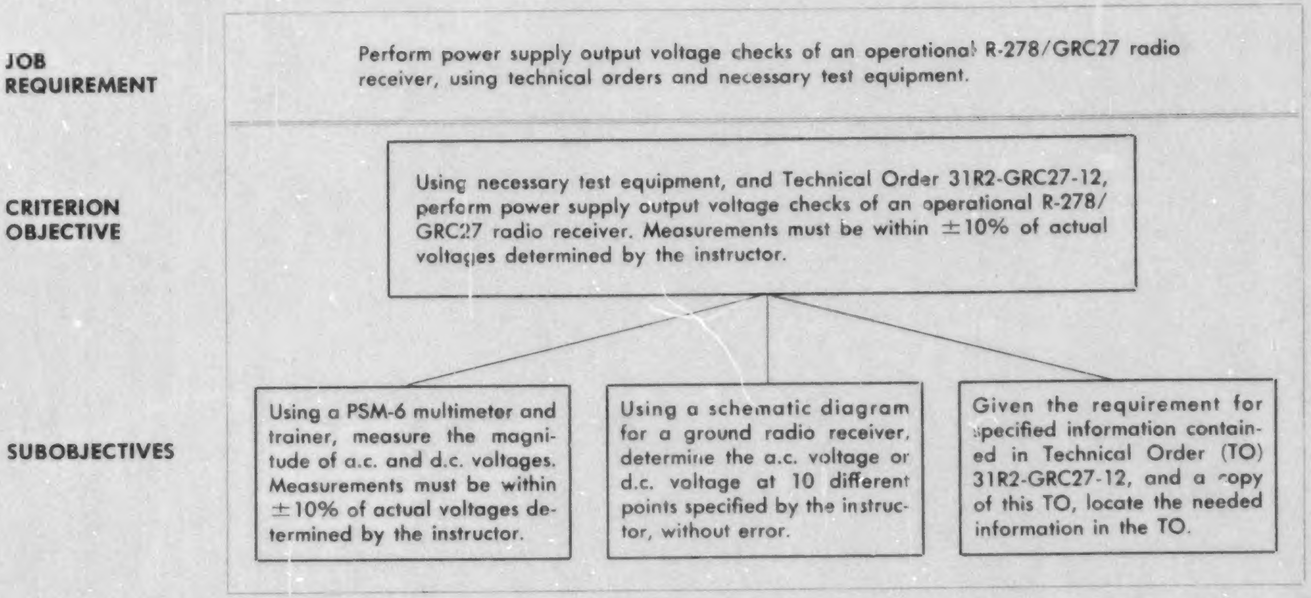
(3) *Standard*. A third requirement of a well-prepared objective is a clearly stated or implied standard of performance. This portion of the objective describes how fast (in 1 hour, 60 words per minute, etc.), how accurately (8 out of 10, ±.001, without error, etc.), or the actual responses that will be considered acceptable. The standard is the criterion for determining whether the student has achieved a satisfactory level of performance.

(4) *Example*. A few examples of statements of objectives that include behavior, conditions, and standards are shown in table 4-1.

(5) *Wording*. An objective which incorporates all three characteristics will communicate the instructional intent to all who are concerned with the instructional system. In stating precisely how the student will demonstrate his understanding of a task, the system designer must not only have *in mind* what the required *behaviors* are, but also must transmit this information to others. The same is true concerning *conditions*. The designer must make clear the conditions imposed upon the student as he performs the end-product behaviors of an instructional requirement. Likewise, he must make certain that everyone concerned understands what degree of success is expected of the student—a *standard of performance*. The wording of the objective is most important since the statement of the objective affects other planning decisions, such as the amount of repetition or practice to provide, the amount of instructional time, and the amount and kind of instructional aids required.

d. USES OF OBJECTIVES. When precisely stated, objectives serve a variety of purposes in the development of more effective instruction. Some of these purposes are to:

(1) establish a basis for instructional strategy decisions;



JOB REQUIREMENT

Perform power supply output voltage checks of an operational R-278/GRC27 radio receiver, using technical orders and necessary test equipment.

CRITERION OBJECTIVE

Using necessary test equipment, and Technical Order 31R2-GRC27-12, perform power supply output voltage checks of an operational R-278/GRC27 radio receiver. Measurements must be within ±10% of actual voltages determined by the instructor.

SUBOBJECTIVES

Using a PSM-6 multimeter and trainer, measure the magnitude of a.c. and d.c. voltages. Measurements must be within ±10% of actual voltages determined by the instructor.

Using a schematic diagram for a ground radio receiver, determine the a.c. voltage or d.c. voltage at 10 different points specified by the instructor, without error.

Given the requirement for specified information contained in Technical Order (TO) 31R2-GRC27-12, and a copy of this TO, locate the needed information in the TO.

Figure 4-1. Hierarchy of Objectives

Table 4-1. Statements of Objectives

BEHAVIOR/PERFORMANCE	CONDITIONS	STANDARDS
Measure and record the thickness of a uniform steel rod,	using a standard micrometer calipers.	Measurement should be within ±.005" of actual thickness.
Devise an operations plan with appropriate missions for AF commands within the theater of operations	when given a war-game problem with data on equipment, location, force disposition, etc.	Acceptable plan must account for: planned use of aircraft and support facilities; anticipated expenditures of supplies; coordination of operations. Points will be awarded as indicated in the attached rating sheet.
Field strip and reassemble an M-16 rifle,	under conditions of total darkness,	without error, and within 5 minutes.
State the total face value	of any combination of 10 US coins that includes one or more pennies, nickels, dimes, quarters, half dollars and dollars.	(Implied standard: without error)
Identify when each of the following conditions arises in the process of starting and of shutting down aircraft engines: • EGT rises too rapidly • EGT exceeds 780° C • Engine oil pressure remains below 5 psi • Loadmeter indicates zero at 60% RPM • Fuel flow is excessive • EGT fails to rise within 20 seconds of placing starter switch in GND position	given a T-17 aircraft with operating J91-T3 engines, and TO 1T-17B-1CL-1. (checklist).	Should be done without error and without assistance. Recognition and response must take place within the limitations prescribed in TO 1T-17B-1CL-1.

(2) determine appropriate content of the instruction;

(3) establish a basis for instructional media decisions; and

(4) establish a basis for criterion tests.

In addition, objectives serve a valuable purpose when they are included in instructional materials that are provided to the student. Studies have indicated that communicating the intent of instruction to students enhances learning.

e. Preparation and Documentation:

(1) The statement of an objective should be interpreted in the same way by student, instructor, and all others who must work with it. For this reason, vague words and phrases that can have several interpretations should be avoided. Examples of these are statements which call for the student to:

know
have an awareness of
have a knowledge of
be familiar with
understand
develop an appreciation of
make proper use of

Instead, action verbs should be used because they are more specific. The verbs used should reflect actions that are observable and measurable. Each of the following verbs indicates a specific type of behavior which is observable and measurable:

adjust
compare
design
plan
predict
record

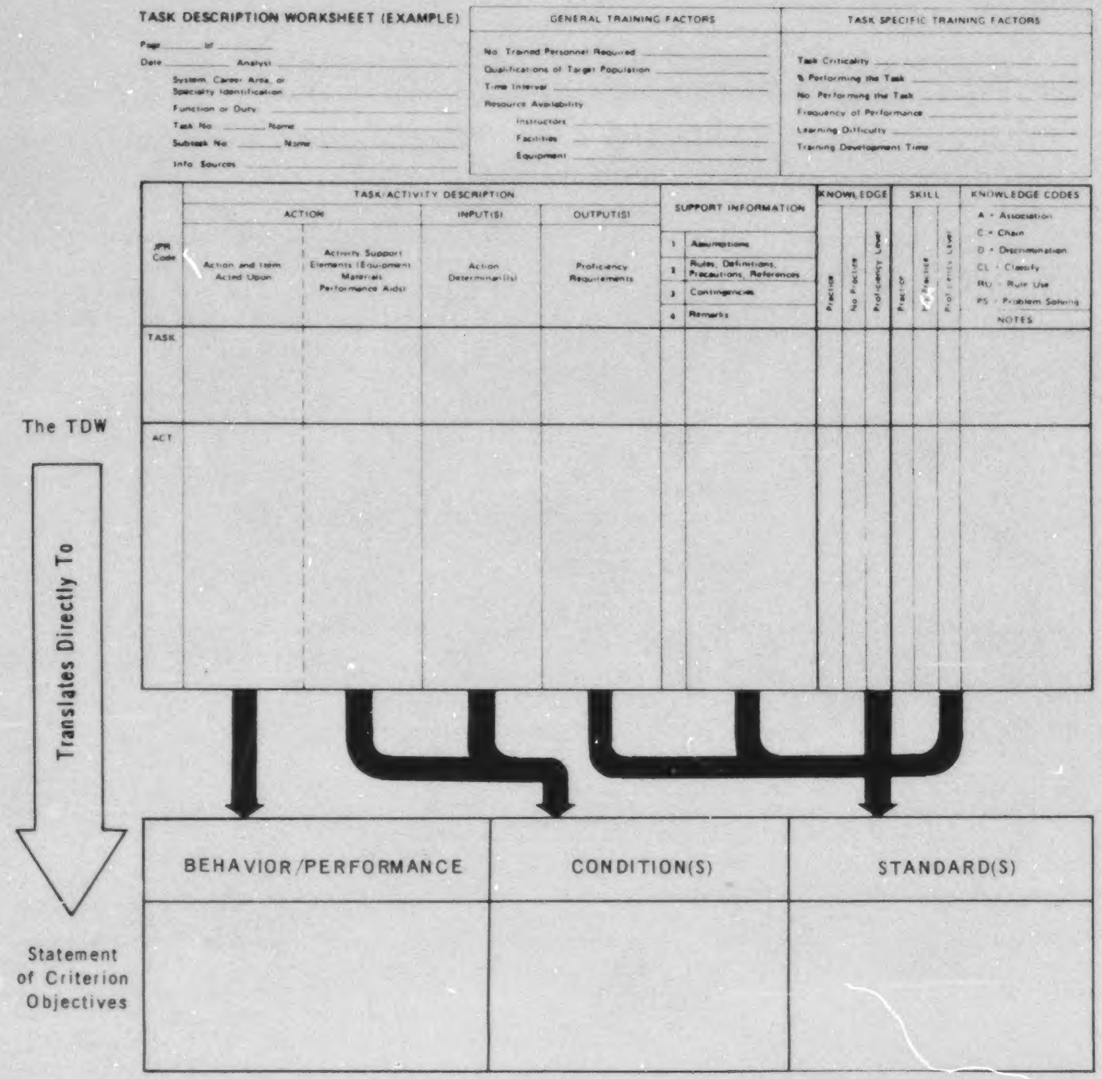


Figure 4-2. How the Three Parts of an Objective are Derived from the Task Description Worksheet

file
locate
measure
multiply
name
remove
repair
select
solve
translate

(2) Objectives are developed through a careful analysis of the instructional requirements that were established in Step 2 of the ISD process. If the Task Description Worsheet (figure 2-1), or equivalent, was used to derive the instructional requirements, the same worksheet can be used as the source of the objectives. Figure 4-2 shows how the performance, conditions, and standards can be drawn from this worksheet.

(3) Figures 4-3 and 4-4 show a worksheet that can be used to record an objective. A separate sheet should be used for each objective. (This will facilitate sequencing the objectives later during the instructional design.) The task/knowledge statements, as already noted, can be taken from the task

OBJECTIVE WORKSHEET

INSTRUCTIONAL STANDARD NUMBER: CH52—3AIR75100-X

TASK/KNOWLEDGE STATEMENT	STATEMENT NO	PROFICIENCY LEVEL
Select and use appropriate methods and techniques to achieve lesson objectives.	4f	3b

PERFORMANCE/BEHAVIOR(S)	CONDITION(S)	STANDARD(S)
Select an appropriate instructional method to teach an objective.	Three different assigned objectives. For each objective, information describing student characteristics, available resources, and available time will be provided. Accomplish without assistance from the instructor.	For each of the three objectives, the method selected must be compatible with all of the following: • the objective • student characteristics • available time • available resources.

OBJECTIVE #4f-1

Given a lesson objective, supporting reference material, information describing the student population, and a description of the time, training equipment and resources available, select an instructional method for achieving the objective that will be compatible with student capabilities and available time and resources. Do this for three different objectives, without assistance.

SUPPORTING SKILLS/KNOWLEDGES/ATTITUDES

Identify characteristics of each of the following instructional methods: case-study, demonstration-performance, field trip, guided discussion, laboratory, lecture, peer instruction, team teaching.

Figure 4-3. Use of Objective Worksheet (Example A)

description worksheet, or equivalent. When the instructional standard is prepared, the portion of that standard which the objective supports can be shown under the headings STATEMENT NUMBER(S) and PROFICIENCY LEVEL(S). This provides a means for documenting how the instruction supports the instructional standard. In this connection, it should be noted that there is not necessarily a one-to-one relationship between objectives and task/knowledge statement in the instructional requirements (or statement in the instructional standard). Several objectives may be required to support a task/knowledge, or, conversely, a single objective may support several tasks/knowledges. The worksheet (figures 4-3 and 4-4) also allows for the listing of those supporting skills/knowledges/attitudes which must be attained before the student can reach the objective. The format in this worksheet is not intended to be fixed; variations may be appropriate in some situations.

(4) For instruction involving the operation and maintenance of equipment, it is comparatively easy to develop behaviorally stated objectives. For other kinds of instruction, it may be more difficult to do this, but the analysis of behaviors should be just as precise as for that involving equipment. Traditionally, education courses have had a fixed length, and often there has been no clear-cut instructional criterion for successfully completing the course. In part, this is because such courses entail the learning of knowledges, skills, and attitudes which are very general in application. Because the instruction has general application, it is difficult to establish realistic standards of proficiency for the instructional objectives. Yet more and more educational institutions are finding ways

OBJECTIVE WORKSHEET

INSTRUCTIONAL STANDARD NUMBER: CH52-3AIR75100-X

TASK/KNOWLEDGE STATEMENT	STATEMENT NO	PROFICIENCY LEVEL
Select and use appropriate methods and techniques to achieve lesson objectives.	4f	3b

PERFORMANCE/BEHAVIOR(S)	CONDITION(S)	STANDARD(S)
Prepare a lesson plan.	Use one of the objectives assigned for objective #4f-1. Use instructional method selected to teach this objective. Collection of reference material. Information describing student characteristics, available time, and available resources. Accomplish without instructor's assistance.	Lesson plan will include: • instructor's preclass preparation • outline of instruction (sequenced in job performance, psychological and/or logical order) • criterion test item(s) • summary Plan will be compatible with the objective, instructional methods, student capabilities, and available time and resources.

OBJECTIVE #4f-3

Using one of the objectives assigned in connection with Objective #4f-1, the instructional method selected for that objective, collection of relevant reference material, and information describing student characteristics, available time, and available resources, prepare a lesson plan without instructor's assistance. Lesson plan should plan for the instruction necessary to achieve objective. Lesson plan will include: instructor's preclass preparation; student motivation; outline of instruction; criterion test; summary. Lesson plan will be compatible with the objective, instructional method, student capabilities, and available time and resources.

SUPPORTING SKILLS/KNOWLEDGES/ATTITUDES

List purposes of lesson plan.
List parts of a lesson plan.
Accept need for lesson planning as indicated by preparation of a lesson plan when the requirement is optional.
Apply learning theory in selecting means for: motivating students, sequencing instruction, ensuring active student participation and reinforcing instruction.

Figure 4-4. Use of Objective Worksheet (Example B)

to resolve these problems. Fixed length of instruction is being replaced by fixed achievement requirements. Since the amount of time to attain fixed achievement is not uniform for all students, course length is now variable. In many cases, individualized instruction has replaced group instruction, thereby facilitating fixed achievement requirements and variable course length. A content analysis approach (similar to that described in chapter 2) is used to establish a basis for the definition of objectives, so that criteria for successful completion of the course can be established. Even attitude and motivation objectives, which usually are considered the most difficult to pin down, are being specified, using a goal analysis approach (described in chapter 2).

(5) Analysis of the job training requirements for many jobs will reveal elements that are common to a number of tasks. As examples: an electrician must be able to read wiring diagrams in connection with many of the tasks he performs; a number of the instructor's tasks require that he apply motivational techniques; and reading and

interpreting the altimeter is common to many of the pilot's tasks. It may increase the efficiency of instructional development to identify these common elements and specify objectives for them.

4-3. Identification of Supporting Knowledges and Skills. Once objectives have been developed and documented, the knowledges and skills which support each objective can be identified. Each objective is examined to determine intermediate steps (subobjectives) in the learning process which must be attained before the student can successfully accomplish the objective. Some of these subobjectives involve intermediate skills which must be mastered before an objective can be accomplished. Others pertain to specific concepts, principles, and facts which must be learned. Thus, the subobjectives pertain to both skills and knowledges, which are identified through a behavior analysis.

a. In its purest sense a behavior analysis is an analytical process based on empirical data. Its purpose is to determine the skills and knowledges directly related to task performance. The final product of a behavior analysis will include three things:

(1) A complete, precise listing of each skill and knowledge that must be taught in order to prepare the student to perform the task.

(2) A determination of the environment or conditions under which the student will perform the task.

(3) The factors which constitute acceptable performance by the student.

The analyltical process consists of a review of all course control documents, field surveys, tasks observation, and any other process which will lead to empirical data about the actual performance of the task.

b. Identifying the skills and knowledges necessary for attainment of an objective is rarely a simple process. Because skills can be observed and knowledges cannot (and therefore must be inferred), it is more difficult to identify precisely what knowledges are needed to satisfactorily perform a job task than to identify the skills required. The only knowledges that should be included in an instructional program are those required in the performance of a job task or tasks (manipulative or mental).

c. The following list of questions may be used as a means for identifying job and task behaviors for which knowledge may be required (13). These questions do not provide a method for determining what specific knowledges are required to perform a task. Rather, they are intended to help identify those job activities for which knowledge, of a kind pertinent to a particular question, will likely be of assistance in learning and performing the activity.

(1) Is a knowledge of nomenclature and location of components required?

(2) Are safety precautions involved?

(3) Is the interpretation of symbols or signals necessary?

(4) Do calculations have to be performed?

(5) Are the techniques of problem solving, diagnosing, and troubleshooting required?

(6) Does the task require the anticipation of later conditions from earlier conditions?

(7) Is planning involved in the accomplishment of the task?

(8) Is the selection of strategies involved?

(9) Must the task be performed in accordance with briefing instructions?

(10) Is the use of tools and general test equipment required?

(11) Is knowledge of the *why* of a procedure essential?

In answering this last question, caution should be exercised to avoid including unnecessary instructional content. On the other hand, it would seldom be economically practical or even educationally sound to teach a student a complex task by merely having him duplicate steps of the task as they are performed by a technician. He should be taught the basic skills and knowledges required on the job, that is, to perform simple motor acts, follow technical order procedures, identify components, and state a fact or explain a principle.

d. An examination of the objective shown in figure 4-4 suggests that supporting skills, knowledges, and attitudes must be acquired before the student can achieve the objective. These are identified in the bottom block of figure 4-4. When stated in behavioral terms, they represent objectives of instruction which must be attained as intermediate steps in the learning process. Finally, statements resulting from the analysis of these subobjectives should identify the basic skills, knowledges, and attitudes needed. These should include the kinds of discriminations which must be made, the decisions necessary, the identifications needed, the principles and facts to be learned, the procedures to be followed, and the motor responses required.

e. Once the objectives have been analyzed, tests can be developed to measure the student's achievement of these objectives.

4-4 Development of Tests. Tests serve a variety of purposes. This portion of the manual will explain the development of criterion tests, diagnostic tests, and survey tests.

a. CRITERION TESTS. Criterion test items are prepared and administered to evaluate the student's attainment of the objectives and to measure the effectiveness of the instructional system.

(1) *Characteristics.* Each test item should be based solely on the requirements specified in the objective which the item is to measure. Thus, an appropriate test item for the objective "Parallel park a car between two cars without hitting either car" would be to require the student to actually parallel park a car between two cars. Multiple choice questions about parallel parking would not be an appropriate measure of the student's attainment of the objective. Neither would requiring the student to parallel park a car that has a trailer attached.

(a) Once it is determined that all objectives are essential, a test should be prepared which will measure each objective within the parameters established by the objective. To show that he has atttained the objective, the student must either meet or exceed the specified standard of performance. This is basically a go, no-go type of measurement. How well one student does is not determined by how the other students do. Tests which rate individuals with respect to standards of performance that are specified in objectives are called criterion-referenced tests.

(b) Norm-referenced tests—tests which are "graded on a curve"—serve a very different function from criterion-referenced tests. Norm-referenced tests compare how well one student performs with the performance of others in his group. Although norm-referenced tests are useful in providing a relative standing among students, they have little value as a quality control for the evaluation of an individual or an instructional system. Criterion-referenced tests are the only ones appropriate for measuring attainment of objectives and effectiveness of instruction. For those situations where relative standing among students may be needed, norm-referenced testing may be used as a supplement.

(2) *Preparation.* To emphasize a point made earlier, each criterion test item should be based solely on the requirements specified in the objective which it is to measure. In fact, the wording in both the test item and the objective may be identical. In an automotive course, for example, one may find the following criterion objective: "Using an electrical test set, adjust the voltage regulator until the voltmeter indicates 14 volts, within a tolerance of ±.2 volt." In this case, the objective itself is a good test item; in others, some rephrasing may be necessary. In any case, a test item should require students to respond only as specified, under established conditions, and with the minimum level of acceptable performance.[2] In the objective cited above, the student is expected to perform the task. The corresponding test item should require identical performance[3] by the student—not merely have him state the procedures that are involved in the adjustment of the voltage regulator.

(a) For some objectives involving safety or very expensive equipment, it is necessary to use simulation in the instruction, and it is also necessary to use simulation in the testing. Thus, the student's ability to defuse a bomb probably would be tested using a simulator. Another type of situation is found in some education courses that deal with job-world problems. Here it may be necessary to test with a simulated problem, such as a case study, instead of using the actual situation. For example, a squadron officer course might include the management decision process involved in setting priorities. It may not be possible to let each student be a "squadron commander for a day" and actually face the real problems. In this case a simulated performance test could be created: the student is seated at a "squadron commander's desk" with an inbasket of simulated correspondence requiring action, and some fellow-students play the roles of squadron members who have problems to take up with the "commander." In each of the above examples the behavior in the simulated situation, and the standards of performance, are the same as in the job setting; but, the conditions under which the behavior is to be exhibited are only similar. It must be kept in mind, however, that the objective defines student performance in the instructional (as opposed to job) setting. Objectives specify what is to be achieved during instruction that will enable the student to perform adequately when he is on the job.

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[2] Minimum level of acceptable performance does not imply weak or inadequate performance. The minimum acceptable performance may be perfection.

[3] *Performance* is not limited to physical manipulations such as writing or welding. There also is performance when one adds numbers, makes a judgment, etc. Performance of the latter kind can only be observed indirectly as when the sum of the numbers, or the judgment, is written or spoken.

(b) Other alternatives would be to measure the subordinate competencies of the objective separately or to measure some performance which is known to be correlated with the criterion performance of the objective (14). An example of the latter would be where the job performance requirement is the ability to troubleshoot a piece of complex equipment such as a radar set. It is not practical to test the student on his ability to successfully troubleshoot every possible malfunction. Instead, the student might be required to troubleshoot a limited number of malfunctions which are considered typical in terms of the basic skills and knowledges involved.

(3) *Concurrence*. When the objectives have been established and criterion test items devised to measure them, the objectives and test items must be approved by the authority designated in related directives.[4] With this approval, the approved objectives/criterion-test-items package becomes the agreed target. Instruction must then be designed to enable the students to reach that target.

b. DIAGNOSTIC TESTS:

(1) As indicated earlier, the criterion test is used to help the instructional system designer evaluate the student's attainment of the objectives and to validate the instructional system. Test items must also be prepared to determine attainment of the supporting skills and knowledges which contribute to the ability to perform the objectives. As with the criterion test items, these diagnostic test items should measure precisely what is to be taught—no more, no less.

(2) During validation, the instructional system designer can effectively use diagnostic test items to predict success, to identify problem areas, and to adjust instruction for unanticipated individual differences. Once the instruction is validated, it would seem that there would be no further need for the diagnostic tests. For if the student can pass a criterion test item, this should be evidence that he not only has attained the related objective, but also that he has mastered the component skills and knowledges. However, if the instructional testing of a validated program is limited to criterion test items, there can be a delay before it is discovered that a student has not learned. Judicious use of diagnostic tests is appropriate, and will avoid this problem. But extensive use of diagnostic tests during instruction, when the instruction has been validated, is costly and unnecessary.

c. SURVEY TESTS:

(1) *Purpose*. Survey tests are designed to determine what prospective students (the target population) already know or can do before receiving instruction. They should not be confused with pretests, though the design of both may be similar. The survey test is administered while the instructional system is being developed and provides valuable clues for its design. The results of the survey will aid in deciding which objectives require instruction and which can be deleted because the student population has already mastered them.

(2) *Preparation*. The survey test should include items selected from the criterion objective examinations. Ideally, the ability to accomplish

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[4] Concurrence of the using organizations is obtained through coordination on the instructional standard.

all criterion objectives should be measured. In addition, the test should survey related abilities of the prospective student, such as reading, writing, and making certain mathematical calculations if these abilities are required in the attainment of course objectives. The degree to which survey testing can be effectively accomplished, however, is contingent on several factors, such as the availability of:

(a) prospective students.

(b) valid tests (in-house or commercial).

(c) facilities.

(d) equipment (when testing performance).

(e) funds.

(f) time.

(3) *Use of test results.* As indicated before, survey tests can be used effectively to determine course content and depth of instruction, especially in areas af basic skills and knowledges. For example, if it is determined that nearly all of a sample of prospective students can accomplish a particular task or that they know a certain piece of information, then this skill or knowledge may not have to be taught. Conversely, if few can exhibit mastery of a particular skill or knowledge, then, more than likely, the corresponding objectives should be included in the instruction. However, decisions on what instruction should be deleted or included should not be made arbitrarily even when nearly all of the students sampled can satisfactorily perform a certain task, without considering such factors as:

(a) How can instruction be economically provided to the few who do need it?

(b) Are there seasonal variations in the aptitudes of the prospective students?

(c) How difficult is the task to learn?

(d) How critical is the task to mission success?

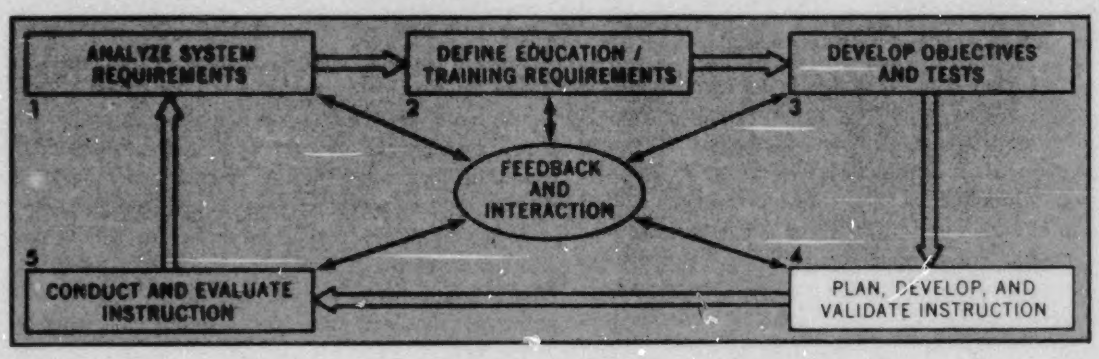
These and other questions must be answered before system designers can make valid decisions to delete objectives from an instructional program.

d. PRETESTS. Pretests are designed using procedures similar to those used for survey tests. Student ability to achieve each criterion objective should be measured. Generally, a pretest is used after the instructional system is in operation. When planned pacing is used to accommodate the varying needs of students, the pretest is administered to each student prior to instruction to determine the extent of his knowledge and skill relevant to that instruction. How well the student performs on the pretest determines what instruction is then provided.

4-5. Summary. Objectives represent the specific intent of instruction in terms of behavioral end-products based on job requirements. Subobjectives establish the intermediate skills and knowledges necessary to satisfy the requirements of the criterion objectives. In and of themselves, objectives have little significance if tests are not developed which will precisely measure the behaviors specified by the objectives, as well as validate the success of the instructional system. These are the functions of criterion tests. When practical, survey tests are prepared to determine which objectives should be retained in the instructional system. Pretests may also be prepared at this time if it is anticipated that an individualized instructional design will be incorporated in the next step. Once these activities have been accomplished, the system designer can plan, develop, and validate instruction.

CHAPTER 5

Planning, Developing, and Validating Instruction


ANALYZE SYSTEM REQUIREMENTS
1
DEFINE EDUCATION / TRAINING REQUIREMENTS
2
DEVELOP OBJECTIVES AND TESTS
3
FEEDBACK AND INTERACTION
5
CONDUCT AND EVALUATE INSTRUCTION
4
PLAN, DEVELOP, AND VALIDATE INSTRUCTION

5-1. Introduction. The results of Step 3 are a set of objectives with related test items. These objectives and tests identify what is to be taught. The contents of this chapter will be concerned with how the material will be taught, and how to determine whether or not the instruction is effective. The activities discussed in this chapter include:

a. how to plan and develop the most efficient and effective learning environment utilizing principles of learning;

b. how to sequence instruction to provide for optimum learning;

c. how to select instructional methodology, equipment, and aids to facilitate the learning process;

d. how to determine resource requirements; and

e. how to validate the instructional system.

5-2. Planning Instructions:

a. MANAGEMENT OF LEARNING. Learning is defined as a change in the behavior of the learner as a result of his experience. In accomplishing Steps 1 and 2 of the ISD process, both the desired behavior (job performance requirements) and the current capabilities of the target population were identified. The difference between the two is the learning deficiency that must be made up by instruction. This instructional requirement was then described as a set of objectives (Step 3). Now that the instructional designer knows what behaviors must be shaped, he must plan the means for doing this. The instructional planning should use the following concepts for effectively managing the learning process.

(1) *Active student participation.* The instructional designer and the instructor can only arrange for learning to take place. It is the *student*

who does the learning. He learns by doing, thinking and feeling—by answering questions, discussing, computing, manipulating, putting ideas together, etc.—provided that the specific activity is appropriate to what he is trying to learn. Until the student has applied in an appropriate way what he was *taught*, it is a risky presumption to assume that he has learned. Learning is an individual process in which students acquire knowledges, skills, and attitudes through their own activities, experiences, and motivation.

(a) When the teaching of knowledge is critical, learning can be enhanced by using questions throughout the lesson. Each question should support one or more learning objective and require an answer that is within the scope of the teaching-learning activity. Learning can be further increased by requiring each student to respond.

(b) When a skill is being taught (for example, use of water fog to extinguish a class A fire), each student should accomplish every step of the exercise; performance is essential. In addition, techniques such as demonstration and films can often be used to assist the students in forming a mental picture or in remembering a process. In situations where complex tasks are taught, an instructor may need to lead students through each step of the exercise before allowing them to proceed on their own.

(c) Because definition and measurement of attitudes is more difficult, designing instruction to shape attitudes is also more difficult. However, as with skills and knowledges, if desired attitudes are to be developed and/or undesirable attitudes extinguished, it is equally necessary to plan suitable instructional experiences. One effective approach to shaping attitudes is human modeling—setting or otherwise providing a desired example for the student to follow. Guided discussion also works effectively for affective lessons, as it requires the student to support and defend their respective positions on the issue of concern. Yet another proven approach is the appropriate application or withholding of rewards. (Chapter 7 includes suggestions for designing instruction to shape attitudes.)

(2) *Confirmation (knowledge of results).* As the student participates, through various types of responding, it is helpful to him (that is, contributes to more efficient learning) to know how well he is doing. Confirmation consists of informing the student whether or not his response is correct. This kind of feedback may also provide a valuable source of motivation. The research is not as clear when it comes to the specifics of how to use confirmation in instruction. The general conclusion seems to be that in the beginning stages of instruction, when it is important to build confidence in the student, confirmation should be provided for each response. As the instruction progresses, confirmation may be provided on an intermittent schedule.[1] In considering if confirmation should be provided immediately after the student has made his response, the same rationale would apply. The type of learning involved, the distribution of practice, and the complexity and method of presenting the subject matter will necessitate variations in the time interval between student response and confirmation. Knowledge of results may be provided in several forms. For example, it may arise naturally out of a task environment where a student is required to select the switch position that turns on a specific light. When the light comes on, the student knows he has made the right choice. During a later exercise when the student is wiring an electronic circuit, confirmation can be supplied by the instructor. He may merely check the individual's work at appropriate intervals and let him know if he is proceeding in the correct manner. When discovering an error, the instructor should point out the mistake and provide sufficient individual tutoring to allow the student to continue the exercise. In another situation where students are using a response device to answer questions during a discussion or demonstration, knowledge of results may come from the device itself or it may be supplied by the instructor.

(3) *Planned pacing.* The rate at which students proceed through an instructional sequence is referred to as pacing. There are several ways to pace students' progress.

(a) Traditionally, instruction has been presented in a lockstep fashion; that is, all students in the class received the same instruction at the same time. However, this method of conducting instruction is inappropriate in many teaching-learning situations. When all the students in a class are required to progress at the same rate, frequently some will become discouraged, and their performance will probably be minimal. The slow student will become bewildered and the student with the higher aptitude, disinterested. There are, however, certain kinds of learning experiences which the students must share. In situations where there must be an exchange of ideas, discussion, or debate, the instructional environment requires a group. Likewise, many tasks impose physical limitations that are beyond the capabilities of one or two people. Therefore, to meet job performance requirements, instruction on such tasks should be accomplished in a group setting.

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[1] *Reinforcement* is often associated with confirmation, but the two terms are not synonymous. Reinforcement has a specific effect on behavior. It makes that behavior more likely to happen again when the same stimulus is present. Confirmation may be a means for providing reinforcement, but it is not the only means.

(b) All students cannot achieve the required level of performance of a task in equal time. Because of varying ability, background and motivation, some will learn faster than others. Ideally, then, the instructional designer would plan for each student to go through the instruction at a pace best suited to the student. Although self-paced instruction is desirable, application of this pacing method to complete courses is not always practical. First, the teaching-learning situation may require a group. Second, in a completely self-paced course, students will complete the program in various lengths of time. This can create student graduate assignment problems in the case of pipeline students. This constraint can be overcome by realigning assignment policy to synchronize with production rate. Other limiting factors in the use of self-paced instruction may be the availability of equipment, manpower, facilities, time, and funds. Lack of a feeling of group identification may also be a problem in some cases. Where it is possible to use self-paced instruction, usually there is a resultant saving in training time. However, when only the beginning of a course is self-paced, faster students must often wait for the slower ones before entering the lockstep portion, and that does not provide a cost-effective system.

(c) Since the lockstep approach hampers the slow as well as the fast students, and the self-paced approach may be limited by certain constraining factors, a commonly adopted approach is to use a compromise between the two methods. Fortunately, many instructional systems can use planned pacing which combines the lockstep approach where necessary and self-paced instruction wherever possible, but the cautions mentioned above must be kept in mind.

(d) Several variants of planned pacing can be used to accommodate the varying needs of students.

_1_ Proficiency Advancement. This is an acceleration technique which can be used to advance students who have prior knowledge, practical experience, or who are exceptionally rapid learners. Students demonstrate their proficiency by accomplishing the criterion test for a particular instructional sequence. The students are advanced accordingly through each sequence in which proficiency has been satisfactorily accomplished. One variation of this technique is where the student is allowed to complete one or more instructional sequences of a course on his off-duty or remedial study time by studying the regular course materials. Again, the student is moved ahead through each sequence in which he demonstrated satisfactory achievement. Proficiency advancement is an especially plausible function for use in upgrade training programs.

_2_ Multiple Tracks:

_a_ The technique of using multiple tracks allows students with varying capabilities, prior knowledges, and learning characteristics to be placed in an instructional track suited to their needs and appropriate to their abilities. Practical considerations generally necessitate limiting the number of tracks to two, three, or four. Usually, student placement in these tracks is determined through the use of a pretest as discussed in chapter 4.

_b_ Multiple tracks could also be used where it is known that following graduation the students will have different assignments. For example, weapons mechanics (AFSC 46230) who are to be assigned to Air Defense Command, Strategic Air Command, and Tactical Air Command following completion of the basic course have different training needs. After receiving instruction based on common needs, each group is placed on a different track to receive the instruction that is command-peculiar.

_3_ Modular Scheduling:

_a_ In modular scheduling, the instructional system is divided into units of instruction called modules. Each module covers one or more objectives. Students are pretested and counseled to determine their particular instructional needs. Then, an individual program is designed for each student. Pretest results and information obtained through counseling are analyzed to determine the specific modules needed by each student. Structuring a course in this manner will eliminate nonessential instruction and can reduce average course length.

_b_ In equipment-oriented courses in which the sequence of units studied is not critical, modular scheduling can assure fullest utilization of the training equipment. Put another way, modular scheduling may make it possible to manage with less training equipment.

_4_ Self-Paced Instruction. Programmed texts and other programmed instructional materials can be advantageously used to enable each student to progress through the instruction at his own pace. They can be designed to use or not to use the assistance of an instructor. Materials that do not require any instructor assistance can be used for out-of-class study. Normally, there still is a need to set some limits on how much time the student may take for the instruction. If this is not done, and students are given complete freedom to set their own pace, the less-motivated may take an inordinately long time to complete the instruction.

_5_ Learner-Controlled Instruction. Where the students are highly motivated and one of the desired outcomes of instruction is that they develop self-reliance and initiative, learner-controlled instruction has been used successfully. In learner-controlled instruction, the student is given the set of behaviorally stated objectives and a test item for each so that he can determine when he has attained the objectives. He is also informed as to what learning resources are available and where they are. He is free to use any part, all, or none of the resource materials as he deems necessary. When he feels ready, he goes to the instructor to take the unit test.

b. INSTRUCTIONAL INCREMENTS—SEQUENCE AND SIZE:

(1) *Optimum instructional sequence:*

(a) Since the objectives provide the framework for the structure of the system, the sequencing of objectives becomes a very important activity in system development. The sequence of instruction can greatly affect the motivation of a student. Sequencing can emphasize relationships to make instruction more meaningul. Obviously, the more meaningful the content, the easier it is to learn. Proper sequencing also avoids unnecessary duplication in course content. Careful sequencing also prevents gaps in instruction and makes certain that the development of a skill is orderly and that prerequisite knowledges and skills have been acquired prior to the introduction of advanced subject matter content or the performance of more complex tasks.

(b) Course content can be sequenced in any one or a combination of several ways.

_1_ Job Performance Order. One method of arranging instructional content is in the sequence in which tasks and task elements are performed. This places instruction, insofar as possible, within the context of the work environment. As the student learns new tasks, the tasks are related to the duty, while the task elements (knowledge and skill components) are related to the task being learned (15). Learning tasks and task elements arranged in the same sequence in which they are performed in the work environment lends a great deal of realism to instruction. It also provides for better transfer of learning from the instructional to the duty environment. This method of sequencing would be especially applicable to teaching procedures composed of a series of fixed steps. The knowledge and skill elements of one task can quickly be transferred to another related task.

_2_ Psychological Order. This method of arranging instructional content is based on ease of learning. This means that, when possible, the learner moves from the simple to the complex, from the known to the unknown, or from the concrete to the abstract. At the start of any instructional sequence, motivation can be enhanced if the student can relate prior knowledge to that being taught. Likewise, instruction on complex motor skills, generally, is more effective when begun with transferable simple motor activities. For example, a student should be taught to use certain tools on simple tasks before attempting to repair a complicated piece of equipment.

3 Logical Order. Often instructional content falls into a logical pattern because of the combined elements of job performance and psychological order. For greater learning effectiveness, instructional activities should normally proceed from the simple to the complex. Unfortunately, many learning activities do not lend themselves to such an arrangement. Instead of gradually increasing in difficulty as shown on line 1 of figure 5-1, job ordered tasks often create a difficulty pattern similar to that shown one line 2. When developing instruction for such an exercise, the system designer may want to keep the job tasks in their proper sequence, but still allow the students to proceed from the simple to the complex. This can be done by an arrangement of instructor-student activity where the instructor first accomplishes the more difficult parts as the student observes. If it is necessary for students to complete the entire procedure, several operations may have to be designed with a planned decrease in instructor participation for each operation as illustrated in figure 5-1.

This incorporates the whole-part-whole concept. For example, when teaching the assembly of a carburetor, it probably would be best to begin by demonstrating the entire assembly procedure; then to break it into a step-by-step demonstration interspersed with step-by-step participation; and finally to recombine all the elements in a complete run-through of the assembly procedure. However, variations of the whole-part-whole concept may have to be applied in certain situations. As mentioned earlier, if a task is too long to be learned effectively as a unit, it may be desirable to divide the task into several operations—always remembering to emphasize the relationships to the whole task. Finally, the entire task can be practiced in its entirety.

(c) In actual practice, all types of sequencing have a place in course development. The type of sequencing used should depend upon the nature of the task or knowledge being taught and the availability of resources. The following general rules should be considered during the process of sequencing:

1 Place easily learned objectives early in the sequence.

2 Introduce concepts at the first point where the understanding of the concepts is a prerequisite for successful performance.

3 Introduce instruction on prerequisite skills prior to the time where they must be combined with other skills and applied.

4 Place procedural skills and knowledges (within the limitations of equipment and facilities) in the same sequence as required in the work environment.

5 Introduce a knowledge or skill in the task in which it is most likely or most frequently to be used.

6 Provide for practice of skills and concepts in areas where transfer of identical or related skills is not likely to occur.

7 Place complex and cumulative skills late in the sequence.

(d) The documented objectives should now be arranged in an order consistent with the sequencing rules just discussed.

1 First, arrange related objectives in homogeneous groups. For example, the grouping may be by subject, task, or equipment subsystem , such as management of human resources, security, radar navigation, supervision, landing gear, and inertial guidance.

2 Next, the instructional units should be placed into a sequence which will provide for continuity of instruction, ease of learning, and distribution of practice. However, time limitations and availability of resources must be considered. If there are skills and knowledges that are common to a number of tasks, generally these should be pulled out and taught before the first task in which the common element is required. (See AFP 50-58 for guidance on how to identify and handle common-element instructional objectives.)

3 Last, the objectives should be sequenced within each unit of instruction, still taking into consideration ease of learning and continuity of instruction. Again, time and availability of resources may be limiting factors. The sequential arrangement of objectives within each unit of

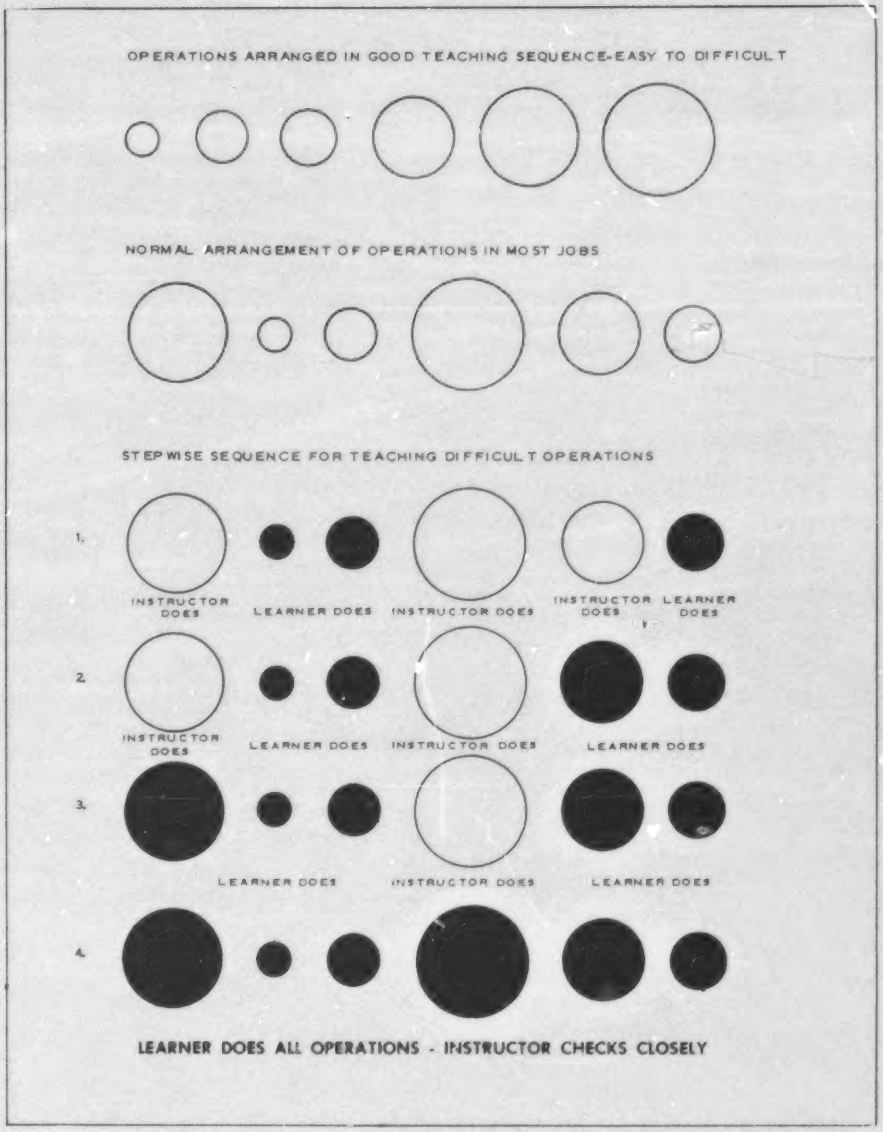
OPERATIONS ARRANGED IN GOOD TEACHING SEQUENCE-EASY TO DIFFICULT
NORMAL ARRANGEMENT OF OPERATIONS IN MOST JOBS
STEPWISE SEQUENCE FOR TEACHING DIFFICULT OPERATIONS
1.
INSTRUCTOR DOES
LEARNER DOES
INSTRUCTOR DOES
INSTRUCTOR DOES
LEARNER DOES
2.
INSTRUCTOR DOES
LEARNER DOES
INSTRUCTOR DOES
LEARNER DOES
3.
LEARNER DOES
INSTRUCTOR DOES
LEARNER DOES
4.
LEARNER DOES ALL OPERATIONS - INSTRUCTOR CHECKS CLOSELY

Figure 5-1. How to Teach Difficult Operations

instruction will provide the input to later development of a plan of instruction or syllabus.

(2) *Optimum-size instructional increments.* Another important concern in ISD is the proper size of each increment of instruction. The term optimum is used to indicate that amount of instruction which is necessary to produce desired results. The natural tendency is to "play it safe" and provide more instruction than is necessary. This makes training more costly than it need be, and may cause boredom and frustration, especially among the more able students. The best approach is to design minimal instruction initially, and rely on the validation of the instructional elements (a process discussed later in this chapter) to reveal where additional instruction is needed.

This process plus additional feedback from evaluation of instruction, should determine the optimum amount of instruction. If *more* instruction than is necessary is provided initially, there will be no good indication that this is so.

c. SELECTING INSTRUCTIONAL METHODS. Although it is necessary to discuss selection of instructional methods and selection of instructional media separately (as will be done in the next few paragraphs), for all applications methods and media cannot be considered separately. The only meaningful question is: which methods/media combinations are the most effective for given instructional purposes?

(1) *Types of learning*. After the instructional objectives have been specified, the essential knowledges, skills, and attitudes to be learned in order to achieve each objective must be identified. When these have been identified, it is necessary to select the instructional methods and media to be used in teaching them. One technique for doing this is to relate the behaviors involved to one or more of the types of learning. (An instructional objective can involve more than one type of learning.) The types of learning, with examples of each, are listed in table 5-1. The first six types of learning listed in this table have to do with knowledges, and have been arranged in a hierarchy beginning with the least complex (association). The next higher type of learning is a chain. Chains are simply two or more associations linked together. Each of the higher types of learning includes all of the lower types.

(2) *Instructional methods*. Various instructional methods are listed and defined in table 5-2 (17). In identifying the instructional method(s) to use to teach a particular skill, knowledge, or attitude, the type of learning (table 5-1) must be considered. Probably, this will still leave several possible alternatives. Considering student differences and availability of time and resources will determine which alternative is most appropriate.

(a) Student Individual Differences. If the planned instruction is to accommodate individual differences, generally it will permit self-pacing. It may also provide for differences in background and experience, and even for differences in learning styles. Such planning rules out some of the instructional method options.

(b) Individualized Instruction. Individualized instruction recognizes that different students have different abilities and needs, and is designed to provide the flexibility to allow for at least some of these differences. Entering students do not all have the same prior experience, the same prior knowledge of the subject, the same learning rate, or even the same "best" way to learn. There are varying degrees of individualization depending on how many of these variables the instructional designer tries to provide for. For example, self-pacing provides individualization for varying learning rates. Individualized instruction can assume one of several different forms depending on whether the course or the learner determines what objectives are to be attained, and what learning activities will be provided to aid the learner in attaining the objectives. These different forms of individualized instruction are represented in figure 5-2.

(c) Time and Resources. Availability of qualified instructors, suitable facilities, equipment, and materials in reference to time allotted for instruction, student load, and class size reflect cost of instruction. These factors will directly affect instructional method selection. Although the basic criteria for selecting a method should be instructional effectiveness, the decision to select among equally effective methods must be made on the basis of cost.

d. INSTRUCTIONAL MEDIA. Instructional media refers to the means used to present information to the student. Examples would range from a classroom instructor to a book, a flight simulator, a computer terminal, prenarrated slides, end items of equipment, or television. Properly selected instructional media supply the information necessary for learning in a form which can be used by the student. Instructional media provide some of the physical circumstances for proper initial learning and for subsequent practice of the knowledge, skill, or attitude to be gained. The necessary information for helping students learn can be given through a wide variety of instructional media and combinations of instructional media. The procedure or strategy for achieving a training objective combines three elements in varying ways: presentation of information, application or practice, and an evaluation which provides feedback

Table 5-1. Types of Learning

TYPE	PERFORMANCES RELATED TO DIFFERENT TYPES OF LEARNING
Forming Associations	Involves associating, naming, or responding to a specific input (stimulus). The person associates the response with a specific input only. The response may be vocal, subvocal (say-it-to-yourself), written, or motor. *Examples:* Naming objects you see; stopping at a red traffic light.
Forming Chains	Involves recalling sequences of actions or procedures which must be recalled in a *specific order*. In a chain the response to one input becomes the input to the next response. May involve chains of verbal responses or chains of motor responses. *Examples:* Verbal chain: reciting a memorized poem; stating a rule. Motor chain: tying a shoelace; starting an aircraft engine.
Making Discriminations	Involves making different responses to the various members of a particular class; being able to distinguish among input information sources and/or types and then to respond appropriately to each. *Example:* Recognizing the differences among similar guages on an instrument panel and reacting appropriately with a vocal, subvocal, written, or motor response.
Making Classifications	Involves responding in a single way to all members of a particular class of observable or abstract events. This involves recognizing the essential similarity among a class of objects, people, events or abstractions, and recognizing the differences which separate those objects, people, events, or abstractions which are not members of the class. *Example:* Classifying aircraft as being tactical, fighter, transport, etc.
Using Rules	Involves applying rules to a given situation or condition by responding to a class of inputs with a class of actions. A rule states the particular relationship between two or more simpler concepts. It is helpful to think of rules as "if-then" statements. *Example:* If a metal rod is heated, then it will expand.
Problem Solving	Involves comparing previously learned rules to create a higher order rule. *Example:* Troubleshooting a malfunction in an aircraft radar system. (Many rules are involved in tracking down the specific malfunction.)
Performing Skilled Motor Acts	Involves manipulative tasks which require the smooth, integrated use of eyes and hands. Often this skill entails variations in the actions, where one action will be dependent on the results of other actions. *Examples:* Making a sensitive adjustment that requires precise timing; shooting a rifle accurately; driving a golf ball.
Exhibiting Desirable Attitudes and Opinions	Involves enhancing an individual's preference for a particular point of view, idea, or course of action. *Examples:* A willingness to obey traffic rules in the absence of authority; exercising safety practices on the job; desiring to master the skills being taught.

to the student. Many instructional media can be used effectively in each of these elements of the instructional process with equal effectiveness. As long as the courseware (such as motion picture films, video programs, programmed instruction booklets, or prenarrated slides) and the training exercise provide all the information the student needs at a rate that he can receive—as long as this situation prevails, it does not make any instructional difference which instructional medium is used. The choice between media of equal instructional effectiveness should be based on other considerations such as cost, maintainability, etc.

(1) *Representative instructional media.* The large number of potentially available instructional media may be separated into five groups, as

Table 5-2. Definition and Classification of Instructional Methods

METHOD		DEFINITION
Presentation Methods	**Lecture**	A formal or semiformal oral presentation of information by a single individual; facts, concepts, problems, relationships, rules or principles presented orally either directly (as by classroom instructor) or indirectly (as by tape recorder, film, or TV).
	Demonstration	Presentation or portrayal of a sequence of events to show a procedure, technique, or operation; frequently combines an oral explanation with the operation or handling of systems equipment or material. May be presented directly (as by a classroom instructor) or indirectly (as by film, or TV, or by tape recorder if oral only).
	Exhibit	A visual or print display used to present information; for example, actual equipment, models, mockups, graphic materials, displays, chalkboard, projected images, or sand table.
	Indirect Discourse	Verbal interaction among two or more individuals which is heard by the student; may be a dramatization, such as role playing, or a dialogue between panel members.
	Assigned Reading	Printed verbal materials such as books, periodicals, manuals, or handouts.
Student Verbal Interaction Methods	**Questioning**	A presenter*-controlled interactive process used to emphasize a point, stimulate thinking, keep students alert, check understanding, or review material. Questioning may be direct, as by a classroom instructor, or may be designed into a film or television presentation.
	Programmed Questioning	A presenter*-controller interactive process used to systematically demand a sequence of appropriate student responses; may be used directly (as by an instructor in a classroom) or indirectly (as by programmed booklets or teaching machines, including computers).
	Student Query	The provision by which students are given the opportunity to search for information, as by questioning a classroom instructor, tutor, coach, or an appropriately programmed computer.
	Seminar	A peer-controlled group interactive process in which task- or objective-related information and experience are evoked from the students. Questions may be used to evoke student contributions, but the seminar is distinguished from questioning.
	Discussion	An instructor-controlled interactive process of sharing information and experiences related to achieving a training objective.
Knowledge Application Method	**Practical Exercises**	Student interactions with things, data, or persons, as is necessary to attain training objectives; includes all forms of simulation (for example, games and interaction with hardware simulators) and interaction with actual equipment or job materials (for example, forms).

* *Presenter* = instructor and/or courseware.

NOTE: Other instructional methods not listed are combinations of those given.

		OBJECTIVES	
		COURSE DETERMINED	LEARNER SELECTED
Learning Activities	COURSE DETERMINED	Individually diagnosed and prescribed instruction	Personalized instruction
	LEARNER SELECTED	Self-directed instruction	Independent study

Adapted from Baird, Belt, Holder and Webb, *A Behavioral Approach for Teaching.* Dubuque, IA: William C. Brown Co., 1972.

Figure 5-2. Four Forms of Individualized Instruction

Table 5-3. Representative Instructional Media

INSTRUCTIONAL MEDIUM GROUP	REPRESENTATIVE EXAMPLES
Classroom instructor with instructional aids	
• Classroom instructor	Lecturer Demonstrator Tutor/Coach
• Instructional aids	Overhead projector Film strip (silent) Film slides Chalkboard
Multimodal media	Prenarrated slides Prenarrated filmstrips Slide/workbook/tape recorder combinations 8mm movies (sound) Cassette television
Print	Books Computers (words and numbers only) Programmed instruction booklets Microfiche
Peer (or peer group)	Role playing Discussion groups Tutoring/coaching
Training devices and simulators	Actual equipment trainers Gaming Interactive computer (simulation) Flight training simulators

shown in table 5-3. This table is not intended to provide an exhaustive list, but rather is designed to show a variety of examples so that the factors promoting media effectiveness may be identified. Descriptions of instructional media as well as advantages and disadvantages of each are contained in AFM 50-62 and in AFP 50-58, volume IV, *Handbook for Designers of Instructional Systems, Planning, Developing, and Validating Instruction.*

(2) *Guidelines for selecting media:*

(a) This portion of the manual provides some guidelines for selecting media. When selecting media, the system designer must consider several factors:

_1_ the design of the specific environment for learning, within the context of the overall training system constraints (see chapter 3) and the instructional objectives (see chapter 4).

_2_ the learning strategy that has been planned, based on the types of learning involved. The role of instructional media will be to enhance the information presentation, the practice, and the feedback elements of the lesson.

_3_ the extent to which individualization of the instruction would be cost-effective.

_4_ which resources are available for developing and producing which kinds of courseware and whether the equipment necessary to present the courseware can be acquired and maintained.

_5_ cost-effectiveness.

(b) The design of student exercises, performances, or practice items is based on the determination of what must be done by the student to provide satisfactory transfer from the learning situation to the job. This activity may range from a student's verbal response in a classroom or filling in the blank in a programmed instruction booklet to operating a Minuteman Missile Procedures Trainer or the C-5 Flight Simulator. Many tasks should be learned under conditions analogous to the job, with equipment identical to that found on the job. However, the practical considerations of cost, safety, and resources often prevent the use of actual equipment in a job-like environment. Further, a well-designed instructional program may employ techniques which make the instructional environment physically dissimilar to the job environment in order to make the instruction more effective. Such techniques include:

_1_ using more feedback during training (student is given more knowledge of the results of his activities) than is normally provided on the job.

_2_ providing many more crises, conflicts, equipment breakdowns, or emergencies at closer time intervals than is normal to the job environment.

_3_ reducing the normal overall operational time of events to increase the amount of practice on critical aspects of selected task performances.

_4_ providing small amounts of practice on selected aspects of similar tasks rather than practicing each of these tasks separately, thus increasing the effective use of limited practice time.

_5_ providing aids, prompts, or guidance during learning. Sources of prompting information include aids incorporated into the training task or job task, job aids (including checklists, picture guides, or other specially designed aid for training), a classroom or field instructor, a classmate (peer), mediated program (such as an automated apprenticeship training approach (18)), handouts, and other resources. Actual equipment may not be designed for optimum training operations. The problem of stripped threads in the "remove-and-replace" training exercises which use actual equipment represents one very apparent aspect of this design problem in training. It is probable that any actual equipment designed and intended for intermittent operation (such as a landing gear retracting system) would not stay operational when subjected to heavy and almost continuous use during the conduct of an efficient resident training program.

(c) An initial step in media selection is to determine which level of resemblance to the job should be selected for the active learning environment. A cross-out matrix (figure 5-3), which lists some potential active learning environments, may be helpful in making this determination (17). An active learning environment will provide the student a working place with some predetermined level of resemblance to the job environment. Tasks

ACTIVE LEARNING ENVIRONMENT	CAN USE TO ACHIEVE TRAINING OBJECTIVE	WILL PROVIDE TRANSFER TO JOB OBJECTIVE	ELIMINATE BECAUSE OF OTHER CONSTRAINTS
ACTUAL EQUIPMENT			
FULL SIMULATION Actual environment and actual response capability			
Physical realism and actual response capability			
PARTIAL SIMULATION Actual environment (physical realism) and synthetic/substitute response			
Simplified/modified cues and actual response			
Simplified/modified cues and synthetic/substitute response			
MOCK-UP, MODEL, PART TASK TRAINER, AND VERBAL			
COMPUTER TERMINAL			
CARREL			
CLASSROOM			
OTHER			

Figure 5-3. Cross-Out Matrix for Selecting Active Learning Environment (17)

with concrete information inputs requiring concrete actions would require a learning environment more nearly like the task (for example, land an aircraft; remove and install an engine; develop efficient reading habits and techniques). Tasks with abstract information inputs requiring the production of abstractions are less likely to require that the training task environment look like the actual task environment (for example, compute budget estimates; identify resistors by color coding; develop layout for fabricating replacement part). The various possible alternatives, including those listed in the matrix, should be systematically considered for use. However, it is necessary to determine whether the training objective can be achieved in the given environment, whether the training objective as achieved in the given environment will transfer to job performance, and whether any other constraints would eliminate a given level of resemblance to the job from consideration. To use the matrix, analyze the feasibility of using each environment. Cross out any level which will not provide effective training or provide transfer to the job. Also reject those active learning environments which are impractical for any other reason, including budget constraints, need to interface with an existing program, excessive lead time, or command policy (assuming, of course, that the possibility or desirability of relief from such constraints has been explored). From the levels of resemblance to the job which remains, ensure that all properties needed for the learning activity remain. Determine also if presentation of information will be provided at the active learning environment or whether another place will be used. Then give priority to the most economical environment which permits achieving the training objective.

(d) There is an implication in the preceding paragraph that the ideal is always to have the instructional situation as similar as possible to the job situation. Generally, this is true, but there are exceptions. Sometimes in the early stages of instruction, resemblance to the job is *not* desirable. As an example, consider the student learning to recognize different forms of bacteria. He could be started off with a microscope and actual stained slides—the job environment. But that would make the instruction unnecessarily difficult because the medium contains much that is distracting. An alternative is to start the student's instruction with a handviewer and slides showing an artist's representation of the bacteria with idealized forms and color and no stain debris. As the student advances in his training, the slides gradually transition to realistic job conditions, and in the final stage of his instruction he uses the microscope and actual stained slides.

(e) To assist the system designer in making preliminary decisions, the types of learning (table 5-1) are shown in relationship to representative instructional media in table 5-4 (17). The designer should be able to relate any instructional objective to one or more of the types of learning, modifying them to include the particular learning processes involved. The strategy, placing appropriate emphases on selected elements of the instructional process, can be achieved using numerous media combinations. The matrix can be used to eliminate inappropriate options, so that realistic trade-offs may be made in the selection of instructional media for the training systems.

(f) Student differences must be considered in the development of an instructional system. Differences among students include rate of learning and achievement; patterns of behavior, interests, motivation, goals, previous knowledge or experience, and readiness; and the capacity to learn and apply learning techniques. Individualized instruction may be used to accommodate individual student differences, reduce redundancy in instruction, provide more efficient management, and provide learner-centered (learning focused on the individual student) performances rather than standardized presentation procedures. Self-pacing, where the student learns at his own rate, provides an effective means of individualizing. While it is generally assumed that different student aptitudes and preferences would require different instructional treatments, the techniques for detecting and using these differences are not adequately developed. Since most of the measures indicating general ability differences predict differential rates of learning, self-pacing procedures now provide the most immediate and largest benefits. The impact of individualized instruction is most visible in the equipment supporting instruction, particularly in the selection of instructional media.

(g) Additional factors must be included in the instructional media selection process. These factors include the ease of student operation of media devices, the level of student control of presentation rate, and ease of repetition for the students' benefit. Equipment for instruction must be easy to set up and operate. Complex operations in preparation for learning will distract from the learning itself, and increase administrative requirements. Various levels of student control of presentation rates are possible with individualized instruction. It is recommended that in self-paced, mediated instruction, the learner be able to stop the program at any point; therefore, a program stop feature should be a feature of the selected instructional media. Spoken words and moving pictures are transient; if they must be repeated for effective individualized instruction, then this capability must be acquired in the selected instructional media. Features for easy program review and timely question/answer (interaction) segments should be provided.

(h) Following decisions about which activities will be performed by the student and which information will be provided to the student via some media, two important questions remain which impact upon media selection. First, how will the courseware[2] which will be presented to the student

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[2] This manual makes a distinction between "courseware," "software," and "hardware." These terms are defined in attachment 1.

Table 5-4. *Representative Instructional Media Suitability for Elements of Learning Strategy (17)*

LEARNING OBJECTIVES AND ELEMENTS OF LEARNING STRATEGY >	ASSOCIATIONS & DISCRIMINATIONS			VERBAL CHAINS			MOTOR CHAINS			CLASSIFYING, RULE USING & PROBLEM SOLVING			PERCEPTUAL-MOTOR SKILLS			ATTITUDES, OPINIONS & MOTIVATIONS		
REPRESENTATIVE INSTRUCTIONAL MEDIA	PRESENTATION	PRACTICE	FEEDBACK	PRESENTATION	PRACTICE	FEEDBACK	PRESENTATION	PRACTICE	FEEDBACK	PRESENTATION	PRACTICE	FEEDBACK	PRESENTATION	PRACTICE	FEEDBACK	PRESENTATION	PRACTICE	FEEDBACK
CLASSROOM INSTRUCTOR																		
Lecturer	YES	NO	NO	YES	NO	NO	P	NO	NO	YES	P	P	NO	NO	NO	YES	P	P
Demonstrator	YES	NO	NO	YES	NO	NO	P	NO	NO	YES	P	P	YES	NO	NO	YES	P	P
Tutor/Coach	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
INSTRUCTIONAL AIDS																		
Overhead Projector	YES	P	P	YES	P	P	YES	P	P	YES	P	P	P	NO	NO	YES	P	P
35mm Slides	YES	P	P	YES	P	P	YES	P	P	YES	P	P	P	NO	NO	YES	P	P
Chalkboard	YES	NO	NO	YES	NO	NO	YES	NO	NO	YES	NO	NO	NO	NO	NO	YES	NO	NO
8mm Movie (silent loop)	YES	NO	NO	YES	NO	NO	YES	NO	NO	YES	NO	NO	YES	P	P	YES	NO	NO
MULTIMODAL MEDIA																		
Prenarrated Slides (with stop)	YES	YES	YES	YES	YES	YES	YES	YES	P	YES	YES	YES	YES	YES	P	YES	YES	P
Prenarrated Filmstrip	YES	P	P	YES	P	P	YES	P	P	YES	P	P	YES	P	P	YES	P	P
Slide/Workbook/Audio cassette	YES	YES	YES	YES	YES	YES	YES	P	P	YES	YES	YES	YES	P	P	YES	YES	YES
Movies (sound)	YES	P	P	YES	P	P	YES	P	P	YES	P	P	YES	P	P	YES	P	P
TV (cassette)	YES	P	P	YES	P	P	YES	NO	NO	YES	P	P	YES	P	P	YES	P	P
PRINT																		
Books	YES	P	P	YES	P	P	YES	P	P	YES	P	P	P	NO	NO	YES	P	P
Computer (words & numbers only)	YES	P	P	YES	P	P	YES	P	P	YES	P	P	NO	NO	NO	YES	P	P
Programmed Instruction Booklet	YES	YES	YES	YES	YES	YES	YES	P	P	YES	YES	YES	P	NO	NO	YES	YES	YES
Microfiche	YES	P	P	YES	P	P	YES	P	P	YES	P	P	P	NO	NO	YES	P	P
PEER																		
Role Playing	P	P	P	P	NO	NO	N/A	N/A	N/A	P	YES	YES	N/A	N/A	N/A	YES	YES	YES
Discussion Group	P	P	P	P	NO	NO	N/A	N/A	N/A	P	YES	YES	N/A	N/A	N/A	YES	YES	YES
Tutor/Coach	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
SIMULATION																		
Actual Equipment Trainer	NO	P	P	NO	NO	NO	YES	YES	YES	NO	YES	YES	P	P	P	N/A	YES	YES
Gaming	NO	P	P	NO	NO	NO	N/A	YES	YES	NO	YES	YES	N/A	N/A	N/A	N/A	YES	YES
Interactive Computer (plasma terminal)	YES	YES	YES	YES	YES	YES	YES	P	P	YES	YES	YES	N/A	N/A	N/A	YES	YES	YES
ACTUAL END ITEMS	NO	P	P	NO	NO	NO	YES	YES	YES	NO	P	P	P	P	P	YES	YES	YES

CODE:
YES—is effective
NO—is not effective
P—under certain circumstances, effective use is possible; or, there are inherent limitations in the effective use
N/A—use of the media is inappropriate

be generated? Second, how will the selected media devices be obtained and maintained? Since instructional media combinations often can be equally effective in presenting the selected information, these two questions may become decisive factors. The first of these noninstructional considerations includes courseware development, courseware production, and courseware revision. Before selecting an instructional medium, it is necessary to determine: who (what organization) will provide the technical expertise to develop, produce, and revise the courseware; and what continuing overhead, new facilities, or personnel would be required for the courseware development, production, and revision. It does not make sense to select a presentation medium for which adequate courseware cannot be developed and provided to the student. Updating of the courseware should be planned for. Experience indicates that a 20 percent revision rate is an average rate suitable for planning when specific related experience data is not available.

(i) The other important question concerns getting and maintaining the selected media devices. A critical factor in the selection of instructional media hardware is availability. What is needed must be matched with what exists and what can be procured. After courseware modes (observing, listening, reading, doing) are determined, available media hardware should be compared and selected according to criteria which include usability, reliability, and maintainability. In general, it is recommended that a courseware presentation format available from only a single manufacturer *not* be selected. Courseware is more likely to remain useful if it can be presented on a variety of available equipment.

(j) Usability refers to the suitability and ease of use by the people who are to use the equipment in the place where they are to use it. It should also be determined if the place where the equipment is to be used can tolerate the potential heat or noise that the media equipment could generate. Reliability refers to the ability of an item of equipment to do what it is supposed to do when it is supposed to do it. Quantitative terms indicating reliability are failure rate (where failure is defined as the inability of the equipment to do the job), mean time between failures and success ratio.

(k) Maintainability refers to the level of difficulty of work by a qualified maintenance person required to keep an item of equipment doing what it is supposed to do for a selected time period. Quantitative data is usually based on downtime (the time the equipment is not available for use). Mean downtime, maximum downtime, maintenance cost/operating hour, manhours/overhaul are common expressions indicating levels of maintainability. The important factor is whether the equipment can be kept operating properly with the available resources. Consideration should also be given factors such as flexibility in adapting to and incorporating new technology in media hardware. Balanced with this should be standardization of media equipment without limiting future capabilities.

(l) In making decisions on media selection, the overall consideration must be, what will permit accomplishing the mission with maximum cost-effectiveness? Each of the media selection considerations discussed have a bearing on this decision. There are other cost-significant factors that must be considered, too, such as: the number of students who will receive instruction, the physical concentration of the students (that is, as many locations across the country, or all at one site), the cost of the hardware, the cost of producing the courseware, the cost of operating and maintaining the hardware, and the cost of keeping the courseware current. For some expensive media, such as television and computer assisted or managed instruction, an alternative to purchasing a complete installation is adding on to an existing system. For example, if a television production and distribution system is installed and available, adding television sets to the distribution system may be cost-effective, whereas buying and installing a complete television production and distribution system may not be.

5-3. Determining Resource Requirements and Costs. Another activity to be accomplished during this step is the identification of total resource requirements. As was stated in chapter 3, it is not possible to identify the total resources needed until some of the activities associated with developing the instructional system have been ac-

TYPES OF RESOURCES AND COST FACTORS

RESOURCES

- EQUIPMENT
  - Instructional
  - Support
- FACILITIES
  - Classrooms
  - Laboratories
  - Special-Purpose
- MANPOWER
  - Instructors
  - Instructional Administration and Supervisors
  - Base Administration and Support

COST FACTORS

- DEVELOPMENT
- INVESTMENT
  - Equipment
  - Facilities
- OPERATION AND MAINTENANCE
  - Equipment
  - Facilities
  - Pay and Allowances

Figure 5-4. Typical Resource and Cost Factors

complished. Leadtime requirements, however, may make it necessary to identify some resource requirements prior to finalizing these activities. The specific activities which need to be accomplished before total resource requirements are established include: the derivation of learning objectives, the identification of instructional media to be used, and the determination of instructional sequence. The results of these activities should provide the information needed to determine total resources.

a. TYPES OF RESOURCES AND COSTS. Several types of resources are required to conduct instructional programs. If instruction is to reach its maximum effectiveness, resources of the right type and quantity must be available on the course start date. Figure 5-4 identifies the types of resources and cost factors that must be considered in developing the instructional system. The following paragraphs provide a brief description of these resources.

(1) *Equipment.* Two types of equipment are needed to support the instructional system. *Instructional* equipment is any item or combination of items used for instruction, whether or not it was specifically designed for that purpose. The function of instructional equipment is to help bring about a desired change in the students' performance capability. *Support* equipment includes any item or combination of items needed to sustain the instructional system. Items classified as support equipment are not used as vehicles of instruction. Some examples of support equipment are: chairs, desks, typewriters, filing cabinets, and mobile power units.

(2) *Facilities.* An instructional facility is the physical complex in which instruction is conducted or which provides for the direct support of instruction. Instructional facilities may consist of classrooms, laboratories, learning centers, or special-purpose areas. These latter facilities are used for the performance of tasks under as near to actual conditions as can be simulated within a controlled instructional situation. Examples of special-purpose areas are: aircraft parking and runup ramps used by aircraft maintenance courses, pole climbing areas used by fixed wire communications courses, or site development areas used by civil engineering courses.

(3) *Manpower.* Manpower is the personnel required to accomplish directed missions and workloads. The timely forecasting of future manpower requirements is imperative, especially when new courses are being developed or existing courses are significantly revised. Manpower requirements for the instructional system include: instructors, administrative personnel, curriculum specialists, writers, and instructor supervisors.

(4) *Costs.* Costs are associated with each of the above resources. However, costs are considered separately since they represent financial require-

ments. In determining requirements for equipment, facilities, and manpower, consideration must be given to the cost of developing the resources, the investment they represent, and the cost of their operation and maintenance. The timely identification and budgeting of these cost factors are just as essential to the development of the instructional system as the planning for any of the other resources.

b. Selection Criteria:

(1) *Establishing resource requirements.* The identification of resources needed to support instruction is influenced by a number of factors. Chief among these are the:

(a) qualitative and quantitative requirements reflected in the instructional standard.

(b) instructional objectives.

(c) number of personnel to be qualified.

(d) time deadlines by which qualified personnel are required.

(e) the manner in which the resources are to be used.

(2) *Other considerations.* The above factors form the basic criteria for the selection of resources. Additional considerations are listed in the following paragraphs.

(a) Equipment. Some additional factors which need to be considered when determining equipment requirements are:

_1_ Large classes may create a need for duplicate equipment in the same classroom. This duplication would permit several students or groups of students to practice performance tasks simultaneously.

_2_ A high student entry rate may also necessitate duplication of equipment.

_3_ Facility limitations such as power, floor area or loading, and air conditioning often affect equipment considerations.

_4_ The equipment should provide for optimum transfer of learning, and allow for ease of operation and maintenance (19).

_5_ The capabilities of instructor and maintenance personnel may also have an impact on equipment selection.

(b) Facilities. Additional factors influencing decisions concerning the number and type of facilities needed to support instruction are: the nature of the instructional activity, and the quantity and type of equipment to be used. These factors often make it necessary to give special consideration to:

_1_ the size and configuration of classrooms, laboratories, and special-purpose areas.

_2_ air conditioning requirements.

_3_ power requirements (both electrical and pneumatic).

_4_ ceiling heights and door sizes to permit entry and positioning of equipment.

_5_ acoustical insulation or baffling to suppress noise.

(c) Manpower. The determination of manpower requirements normally involves the use of management engineering standards or criteria (20). These standards include a definition of the work center; the workload factor, its definition, and the sources from which the workload was derived; and guidance necessary for using the standard(s). For formal courses, principal factors to be checked against these standards are: the average number of groups instructed during a fiscal quarter, and the course student load. Other factors which have a bearing on manpower requirements include:

_1_ student entry rate and group size.

_2_ complexity of tasks to be taught, equipment used to support instruction, and facility availability.

_3_ instructional hours.

_4_ instructor nonavailable time.

(d) Funds. Financial requirements are directly related to requirements for equipment, facilities, and manpower. These latter requirements must be translated into unit costs. These costs become the basis for preparing or revising budgets. A further financial consideration is described in the following paragraph.

(3) *Surveying existing resources.* Prior to making a final determination of resource requirements, a survey of existing resources or current

assets should be conducted. This survey is directed toward reducing the quantity of resources which have to be procured.

(a) Equipment and Facilities. When surveying existing equipment and facilities, the two principal considerations, suitability and availability, can usually be addressed by answering such questions as:

_1_ Does equipment provide for adequate transfer of learning?

_2_ Does the facility have the type and size of space needed?

_3_ Can equipment or facilities be economically modified?

_4_ Can equipment or facilities be cross-utilized?

_5_ Can equipment or facilities be made available without impairing the mission of some existing program?

(b) Manpower and Funds. A survey of these resources will involve examining current programs and authorizations. The purpose of this examination is to determine whether or not resources currently available (or programmed) might be redistributed. The development or revision of an instructional system may relieve some other course of all or part of its instructional burden, thus freeing resources for re-allocation.

5-4. Developing Instructional Materials and Validating Instruction. Another important activity in this step of the model is that of developing the most effective instructional materials to support each teaching-learning activity. These materials include such items as texts, student study guides and workbooks, instructor guides, slides, tape recordings, charts, and case study scenarios.

a. PREPARATION OF INSTRUCTIONAL MATERIALS. The development of material for instructional purposes is a time-consuming and exacting task no matter what type of media has been selected. Usually, the material takes the form of the printed word, either as a textbook, chart, transparency, or a programmed text. Even television and film presentations require the advance preparation of a script. Therefore, effective instructional material depends upon effective writing.

(1) *Survey of existing materials:*

(a) There are times when the writing effort can be reduced through the use of suitable material which is already available. Before preparing new material, the availability and suitability of existing publications and aids should be researched. Suitability should be based on an analysis of the objectives to determine what knowledges and behaviors the student should acquire through the use of the material. If suitable, existing materials can be used to prevent duplication of effort and reduce development costs. Air Force activities are encouraged to use off-the-shelf publications and aids when these will satisfy instructional objectives.

(b) Commercial self-instructional materials are available on a wide variety of subjects, including English grammar and composition, virtually all mathematics subjects, electronic fundamentals, and many aspects of management. The other military services have also developed self-instructional materials, many of these in subject areas that are common to the Air Force. Other publications such as manuals, technical orders, and manufacturers' handbooks for specific equipment should be reviewed for possible application. Some of these may require little or no supplemental guidance for use by the student, and are especially appropriate for instructional use if they are the same materials the student will have to use on the job. Often the use of adjunct programmed instruction techniques can make these materials especially useful for instruction. Air Force and commercial self-instructional materials and other instructional publications and audiovisual packages can be identified through the use of military and commercial indexes, bibliographies, and catalogues. ATC/XPTI, Randolph AFB, Texas, may be able to provide assistance in identifying and locating these materials.

(2) *Development of new materials.* Throughout the development effort, the writer must keep in mind the objectives that the material must support, and the student for whom the instructional material is being prepared.[3] Since the most effective

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[3] Information concerning the student's background, reading ability, and prior knowledge often can be obtained through survey tests (see chapter 4), aptitude tests, such as the AQE, and other tests developed by the Human Resources Laboratory.

instruction is student-centered, the author must also use techniques consistent with the principles for effective learning. The materials must be so constructed that the student will be attentive. His attention must be assured by requiring him to make specific responses to the presentation, by answering relevant questions, by operating a piece of equipment, or by performing some other kind of observable, measurable behavior. The materials must move him in the direction of criterion behavior and guide him toward mastery. By carefully planning the stimuli to which the students will be exposed, and by proper application of reinforcement theory, the desired behaviors can be shaped.

(a) As far as the actual writing is concerned, there are numerous publications, both government and commercial, which can aid in developing and editing instructional materials. An annotated bibliography of some of these publications is contained in attachment 3.

(b) In developing instructional materials, care must be taken to support the human relations concepts to which the Air Force is committed. Minorities (including women) should be proportionately represented in visuals and texual materials. There should be nothing derogatory or demeaning to any group in word or picture.

(c) The instructional materials that are developed should be edited for technical accuracy by subject matter experts. This edit should not be restricted to review of technical content but should include such subtle features as adequate use of tools, appropriate safety precautions, adequate indication of supervision, two-man concepts, and major command policies. These materials should also be edited for composition. This edit must ensure compliance with the AFM 5-1 policy and essentiality criteria. It should also be concerned with the ability of the instructional materials to communicate. Do they use language the learner understands? Are they free of unnecessary repetition and ambiguity?

b. Validating Instruction. At this point in the instructional system development process, teaching-learning activities to achieve objectives derived from job training requirements have been developed. Instructional content has been carefully sequenced and documented. Appropriate methods of instruction and media required to produce an effective learning environment have been selected. Instructional materials which will most effectively support the learning process have been developed. Although great effort has been expended, the project cannot be pronounced successful at this point. It still remains to prove that students instructed in the system can acquire the necessary job skills and knowledges. In developing an instructional system, the proof of quality can only be ascertained through a measurement of results in comparison with the specific criterion objectives. Each step in instructional system development can be validated by checking student performance against the performance criteria. This is referred to as system validation. It should not be inferred, however, that the complete instructional system is developed and then tested all at once; rather, portions of it may be tested as they are produced. The system is developed unit by unit and is tested or validated on the basis of the criterion objectives prepared for each unit.

(1) *Individual student sampling.* Ideally, the first step in the validation process, following the preparation of a small instructional unit, is to test its effectiveness on individual students who are representative of the intended target population. The students selected for the purpose of validation should fall within the range of aptitudes, prior knowledges, skills, and background displayed by the typical input population. Preferably, those selected should possess the higher aptitudes. If they have trouble learning the material, quite obviously the material would be too difficult for the less capable student. Also, the student having higher ability may point out weak areas in instruction. Moreover, if the initial presentation were to be given to students with the lower aptitude, and they did well, it would be hard to assess the relative difficulty of the lesson. It is simpler to expand material to make instruction more effective, than it is to determine what material to delete in order to achieve the optimum level and quality of instruction.

(a) Conducting the Individual Tryout:

_1_ During the individual tryout, a single student is closely observed as he uses the instructional material. Wherever the student has difficulty or seems uncertain, this should be carefully noted, even if it concerns only one teaching point. If a student has trouble understanding or applying one rule or principle, more than likely he will have difficulty in accomplishing the behavior to which that rule or principle applies. This is especially important in that the effectiveness of an instructional segment is evaluated only on the student's ability to perform the behavior, under the conditions, and within the standard specified by the criterion objective. The instrument used to measure this performance is the criterion examination for the corresponding criterion objective.

2 During the process of validation, it is very important that both the instructional materials developer and the student understand their roles in the process. It should be explained to the student that he is not being evaluated, but the system is. He needs to be urged to participate actively and to respond as required. He should also be informed that his responses, with the exception of those he makes during the criterion examination, will be confirmed so that he will be continually aware of his progress. It is through the feedback provided by the student that the instructional materials developer can determine the adequacy of his presentation and the supporting instructional media. During the individual tryout, he should carefully note any problem areas, but refrain from providing additional assistance to the student unless it is absolutely essential to the student's progress. Even then, the instructional materials developer should take notes so that he can later identify and analyze any areas which may reflect an inadequacy in his presentation or deficiencies in supporting media. The instructional materials developer must not forget that the failure of the student to perform competently at this stage is a reflection on the instruction and not on the student.

3 After the student has completed the unit of instruction and the criterion examination, he should be encouraged to discuss any areas in which he experienced difficulty. Several individual tryouts should be conducted before any significant changes are implemented.

(b) Use of Individual Tryout Results. When certain error patterns occur during successive tryouts, it is an indication that revision is necessary. If, for example, several students fail to meet the standard of performance established for a particular criterion objective, the instruction leading to that objective needs to be analyzed. This analysis plus any supporting comments acquired during the student interview will probably identify problem areas and provide the data upon which corrective measures can be initiated. If the instructional unit has to be revised significantly, it would be best to conduct one or more individual tryouts to check the results of the modification before proceeding to small-group testing. However, if the instructional sequence is effective, requiring only minor changes, a small-group validation can be started.

(2) *Small-group tryouts*. The reason for trying out instruction on a group of students is to determine how that portion of the instructional system functions under conditions approximating the actual classroom situation. Then too, it is more economical to gather data concerning the effectiveness of instruction from groups than it is from individuals. Therefore, validation efforts are expanded to small groups of 6 to 10 students as soon as satisfactory results are obtained with individual tryouts.

(a) Conducting Small-Group Tryouts:

1 The first small-group sampling should be continued until a total of 20 to 30 typical prospective students have been presented the instructional sequence. The students selected for this phase of validation should also represent the target population. The selections should include, insofar as possible, an even distribution of low, average, and high aptitude students.

2 Up to this point, the success of the system may have been a result of limiting student sampling to those with the higher aptitudes. Now it remains to be seen if the same instruction is just as efficient in teaching students with lesser ability. It should not be surprising if students with the lower aptitudes also successfully accomplish the assigned learning tasks. They may just take longer to complete the sequence.

3 At this point in validation, time becomes a factor. It is not sufficient that a student learns the material in an instructional sequence; he must also complete it within a reasonable period of time. In an ideal self-paced system, there are

no limits placed on the length of time the students can take in achieving objectives. From a practical point of view, however, portions of many instructional systems will, of necessity, be group-paced. Therefore, efforts to contain a segment of instruction within a realistic period of time should be based on requirements and the capabilities of the average students. In a group-paced situation, it would be just as impractical to pace instruction at a rate to satisfy the fast student as it would be to meet the needs of the slower student. Therefore, during small-group tryouts, the time needed by each student to complete an instructional segment should be tabulated in addition to recording the accuracy of student responses as in the individual tryouts.

_4_ At this time some effort should be made to establish the maximum number of trials the student would be permitted to reach criterion performance. If proficiency advancement and individualized instruction are to be meaningful to the student, there must be some described point at which remedial training or failure is specified. This is particularly true in highly technical and flying training programs. Students who are allowed continuous trials, when they cannot attain success, become frustrated and agitated. The behavioral reactions do not complement the training effort. A remedial program with a new approach or smaller steps may well be the alternative.

(b) Use of Small-Group Tryout Results:

_1_ The small-group tryout should be a success because of the nature of the procedures for individual tryouts. It is probable that any changes that will have to be made in instruction will be minor. As in the individual tryout, if the segment of instruction undergoes a significant revision, groups of 6 to 10 students should be given the modified instruction until additional data have been gathered on 20 to 30 more students. This cycle of teaching, testing, analyzing, and modifying is continued until it is proven that the students can perform to the level specified in the control documents.

_2_ The small-group tryout results will also provide data for planning instructional time requirements. This data may necessitate revision of equipment and facility requirements and instructor manpower needs.

_3_ Although it is desirable to conduct tryouts before the course starts, it is not always possible to do this. There are situations where the students are not available until the course starts, and there is no practical way of getting substitutes for the students in order to get a realistic tryout.

(3) *Operational tryout and implementation.* The final stage of the validation process is not usually conducted by the developers, but by the course personnel who would have to operate the system. The length of the sequence will vary. It may be a portion, a complete block of instruction, or a course of instruction in its entirety. However, availability of time and resources will, to a great extent, dictate the scope of the instructional area undergoing a final operational tryout.

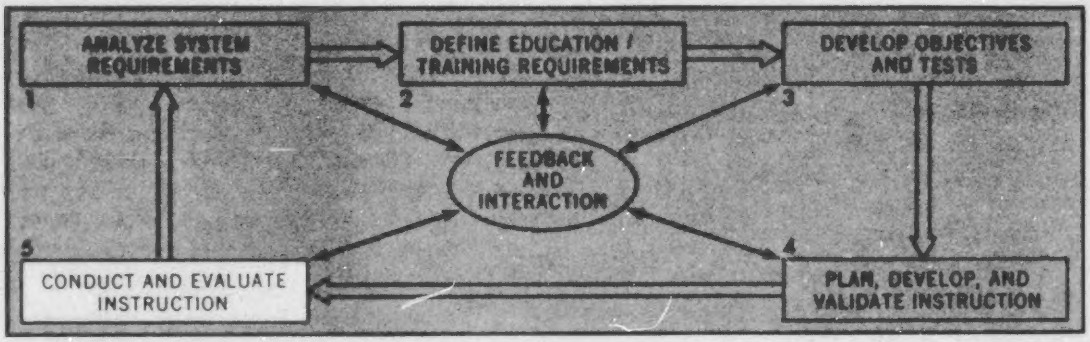
(a) There are several reasons why it is desirable to conduct a complete operational tryout. First, even though the small segments of instruction have proven successful, they have only been validated in an isolated environment. Now they must be evaluated as integral parts of the total system. Second, the analysis of the data feedback from this larger sample population will provide a solid basis for final revision and refinement of the system. Third, it will afford opportunity to work out administrative, equipment, facility, or any other implementation problems which may cause trouble later and to update the course control documents as required.

(b) It would be highly erroneous to assume that once an instructional system is validated and implemented, it becomes a finished product. There will be problems involving instructor qualifications, equipment maintenance, scheduling, and variations in student attitude and aptitude. In addition, changes in operational requirements (for example, changes in the specialty descriptions) impose changes in learning objectives and the associated equipment and instructional materials. To be an effective system, instruction must be continuously evaluated and revised to meet changing needs of the student population, operational requirements, and administrative and management problems.

5-5. Summary. The accomplishment of this step in the model requires the careful planning, developing, and validating of instruction to ensure that the objectives of a course can be effectively and efficiently fulfilled. This involves the sequencing of teacher-learning activities to produce the best possible learning environment. The planning also includes the selection of the most appropriate instructional methodology, equipment, and aids to support these activities. The programming of equipment, facilities, manpower, and funds must be finalized so that such resources are available when required. Instructional materials are prepared, and, finally, all elements of the instructional system are tested and revised until they are validated.

CHAPTER 6

Operation and Evaluation of the Instructional System


ANALYZE SYSTEM REQUIREMENTS
1
DEFINE EDUCATION / TRAINING REQUIREMENTS
2
DEVELOP OBJECTIVES AND TESTS
3
FEEDBACK AND INTERACTION
4
PLAN, DEVELOP, AND VALIDATE INSTRUCTION
5
CONDUCT AND EVALUATE INSTRUCTION

6-1. Introduction:

a. After the instructional program has been developed and validated, it is ready to be put into operation. Planning is necessary to ensure that instructor and supervisory personnel are adequately prepared to conduct and administer the instructional program and that supplies and equipment will be available when needed. There is a special need to prepare the instructors when individualized instruction is used since the role of the instructor is changed substantially.

b. The ISD process does not end when the instructional program becomes operational. The instructional system must be continually evaluated to be sure that is is producing qualified graduates in the most cost-effective manner. Evaluation provides the feedback necessary to ensure that the output of the instruction meets job requirements.

c. This chapter describes:

(1) the changing roles of instructors and students;

(2) the functions of management in the instructional system; and

(3) the process of evaluating the quality of instruction and the proficiency of the graduates to ensure continued instructional effectiveness.

6-2. Conducting a Student-Centered Instructional System. Although many forms of instruction are possible in an instructional system, the basic considerations of the instructional system development process tend to favor student-centered, individualized instruction. This trend is also aided by recent advances in the technology of instruction. Modern technology has not solved all instructional problems, but the advent of programmed instruction, inexpensive tape recorders, slide, filmstrip and film projectors, computer assisted and computer managed instruction, sophisticated aircraft simulators, and other media and devices, is providing an impetus toward more effective, student-centered instruction. The obvious consequence of converting from an instructor-centered to a student-centered instructional system is the pervading effect this has on all aspects of the design of instruction (as has been described in the preceding chapters of this manual). Another consequence is the altered roles of student and instructor.

a. STUDENT-INSTRUCTOR RELATIONSHIP. In a student-centered, individualized instructional system, the instructor becomes a "manager of learning" and assumes the roles of classroom administrator, tutor, and counselor. Instead of dealing with the class as an entity, he is now able to devote much of his attention to the problems and needs of the individual student.

(1) *Classroom administrator.* Despite sophisticated hardware and innovations, the instructor's part in the learning process will never be just incidental. There will always be a need for personnel to motivate, direct, guide, and evaluate students as they engage in the learning activities.

(a) Since no two students have the same learning patterns or prior knowledge and experience, the instructor will be responsible for developing individual study plans. He will focus his attention on the requirements of the individual, rather than the group. This will lead to structuring or programming subject matter based on the needs of the individual student in meeting course objectives. The individual study plans should allow for flexibility in scheduling, revision, and consolidation when group efforts are required.

(b) The instructor will also ensure that instructional materials, equipment, aids, and other supplies are readily accessible to the students; make certain that the equipment and aids function properly; and assist the students as necessary.

(c) The instructor should also make sure that each student is progressing according to his capabilities within the preplanned scope of the teaching-learning activities. If student weaknesses are discovered through an analysis of evaluation data, the student's activities may be rechanneled to remedial sequences or the instructor may provide individual tutoring. The success of each instructional segment should be continuously evaluated as a quality control measure. If deficiences in student performance keep recurring, the instructional segment involved should be analyzed for possible revision.

(2) *Tutor and counselor.* From a practical point of view, it is almost impossible to design an instructional system that will anticipate and provide for all the needs of all the students all the time. Some students will have trouble meeting certain objectives, understanding specific points, and performing certain tasks. The trouble spots will be different for different people. The instructor must be alert for such problems and be prepared to provide assistance as needed. The instructor may have some students who are exceptionally fast or unusually slow. The more capable student can be kept from becoming disinterested and bored if one of the acceleration techniques explained in chapter 5 is used. The instructor must also diagnose the problems of the less capable student. Through observation of student progress and the use of diagnostic tests and pretests, the instructor can determine how to tailor instruction to meet individual needs. This may include providing supplementary materials or remedial instruction.

(a) Motivation probably contributes more to success in learning and to the student's future success than any other single factor. It is the instructor's responsibility to motivate students. This is especially necessary in individualized instruction since the student is more autonomous. Without a desire to learn, there is little probability that adequate learning will occur. Therefore, the instructor must develop techniques which will encourage the student to want to learn. One of the best ways of stimulating a student toward a greater individual effort is to ensure, insofar as possible, that his endeavors meet with success rather than failure. Achievement provides intrinsic motivation, and tends to strengthen the student's self-determination.

(b) The process of providing guidance or of counseling students may be a new role for some instructors, yet in individualized instruction it is a most important function. Unfavorable attitudes, opinions, or emotions can be detrimental to a student's ability to learn. On the other hand, when attitudes, opinions, and emotions are favorable, a healthy climate for learning is established. The alert instructor can aid the students in overcoming their difficulties before the problems seriously affect learning.

b. FUNCTIONS OF MANAGEMENT:

(1) As a result of the application of steps 1 through 4 of the ISD process, instruction has been carefully designed to shape the job relevant behaviors. No matter how careful this planning, the system can break down during implementation if management fails to perform its functions. The system must have the support of instructors, supervisors, and management. There must also be planning to supply and maintain the system. It is management's responsibility to provide this support so that the instructional system can be conducted as planned.

(2) Instructors must understand how the system is intended to function and how they are to function in the system. This information should be provided in an instructor guide prepared by the instructional system designer. Management must assure that instructors study and apply these instructor guides. All personnel concerned must understand that arbitrary changes in the validated instruction cannot be made without endangering the effectiveness of the instruction.

(3) Instructor training (or retraining) may also be necessary. Instructors faced with the task of using new teaching techniques may feel (and may be) inadequate. Therefore, course administrators must ensure that instructors are provided with instruction on the application of new concepts and techniques, as well as the rationale for their use.

(4) Management must also plan for the maintenance of the system. Training literature, expendable supplies, and tools must be available when needed by the students. Training devices must be maintained in functioning condition, and a proper level of spares should be available. If the organization conducting the instruction does not have its own audiovisual equipment, the use of loaned equipment must be carefully scheduled. This kind of planning is always important for effective instruction, but it becomes critical when self-paced, individualized instruction is involved.

(5) For a variety of reasons, instruction will need periodic updating. Revising instructional materials requires the same careful planning, development, and validation as developing the original instructional system materials. Management must plan for adequate, qualified manning to support this effort.

(6) A self-paced instructional system presents several special challenges to management. The problem of keeping track of the current status of each student—what training each student has successfully completed, what his special needs are, and what equipment is available for him to work on next—can be an imposing one. If there are many students involved and/or the scheduling is especially complex (for example, flying training where scheduling is difficult since weather provides an unpredictable variable), it may be necessary to use a computer for the scheduling and recordkeeping. In some cases, there is also a need for forecasting the graduation date for each student so that he can be promptly outprocessed when he has completed the instruction.

(7) Of course, it does no good to develop quality instructional materials and systems unless they are used properly and the skills and knowledges learned by students are applied. This is a problem of management of the students who are selected to receive the instruction. If the students sent to the course do not have the prerequisites, not only is the students' time wasted, but the whole instructional system design effort can be destroyed. The ISD effort is also wasted if the people trained are denied the opportunity to apply their skills and knowledges.

(8) Management is also the key to the effectiveness of the effort to apply ISD in the development of training for new weapon/support systems. Unless support of the ISD effort is included in the developmental planning for a new weapon/support system, the effort cannot produce information on which to make timely and effective instructional decisions. *Support* signifies such actions as making the necessary documentation available to the instructional system designers, and having instructional system designers participate in the early planning to ensure that major instruction and training equipment decisions are based on information derived through the ISD process.

6-3. Evaluating the Instructional System:

a. ISD CYCLE. The ISD model shows that the process is a complete cycle. The feedback from evaluation provides control of the instructional system to ensure continuing quality in graduate performance. If evaluation of the instruction indicates a need for change, the cycle is repeated beginning again with Step 1 of the model.

b. VALIDATION OF PROGRAM. Despite the care with which the instructional program has been developed, it is still possible that the graduate's performance may not meet the job requirements. There may be a number of reasons for this, some of which may be related to the instructional program. Validation provides assurance that the instructional program meets the objectives, but since there is a time lapse between when job performance requirements were determined and when the graduates reach the job, some of the job performance requirements may have changed. Another possible problem is that the training may not have provided sufficient retention. It is also possible that there are weaknesses in the instructional program, that the instruction is not being conducted as planned, or that students who do not have the prerequisites are taking the instruction. Through field evaluation and internal evaluation, such problems can be identified.

c. INTERNAL EVALUATION. Evaluation provides the feedback necessary to ensure continuing quality in graduate performance. The results of internal evaluation do not provide conclusive proof of the adequacy or inadequacy of the instructional system, but they do identify some of the system problems and suggest areas for improvements. This review normally includes the following:

(1) *Control documents.* An internal evaluation must begin with an analysis of the instructional system control documents. This should be followed by a physical examination of every component and every procedure authorized and/or required by these documents. The objective is to determine if discrepancies exist between the planned instructional system as outlined in the control documents and what occurs during instructional system operation.

(2) *Resources.* Internal evaluation should establish whether existing training facilities, equipment, tools, and supplies are meeting the requirements of the instructional system. In addition, support facilities and services should be evaluated for adequacy, condition, and maintenance. If deficiencies are identified, recommendation should be made for corrective action.

(3) *Instructional facilities visits.* Visits to instructional facilities must be made in sufficient number and be of sufficient duration to assure observation of representative teaching. Trainers, instructional media, and aids specified for use in the facilities should be checked for condition, operation, and appropriateness. Instructional literature should be checked for availability and quality.

(4) *Instructors.* The instructors' activities should conform with the specifications in the plan of instruction (or syllabus) and the instructor guides. Instructors must demonstrate appropriate application of instructional system technology. Instructors must be able to detect student problems and react to their needs. Instructor records must be current and show the amounts of inservice and special training completed. The instructor rating sheets completed by the instructor-supervisors should be studied and a determination made as to the suitability of the corrective action.

(5) *Measurement program.* An important source of information as to whether the system is functioning effectively comes from the instructional measurement program. Such a program can:

(a) inform each student of his progress in meeting the objectives of the program;

(b) establish a permanent record of each student's achievement, and allow the student to know what his record is;

(c) identify the need for a remedial program;

(d) identify students who are failing to meet the prescribed standards of the course so that appropriate action can be taken;

(e) provide a basis for the recognition and utilization of students who are outstanding; and

(f) provide feedback data for the purpose of establishing a constant quality control check on the instructional system.

The last objective is probably the most important, in that, it tends to ensure continuing success of the system. Primarily, instruction is evaluated in terms of student attainment or nonattainment of learning objectives. Therefore, the measurement program should consist of performance examinations designed to measure student achievement of the objectives, as described in chapter 4.

(6) *Analysis.* The monitoring of the measurement program is extremely important in verifying the quality of instruction. However, it is still just one aspect of internal evaluation and should not be accomplished to the exclusion of other methods, such as visiting classrooms, or checking the adequacy of equipment and audiovisual aids. Internal evaluation involves an analysis of all of the actions which occur in the operation of an instructional system. If the analysis identifies certain instructional sequences which are not meeting prescribed standards, corrective action can be initiated. The corrective action, in addition to changes in sequence, may involve reaccomplishing other steps in the ISD model.

(7) *Other evaluation.* As important as is the contribution to quality made by internal evaluation, it is only one of the two parts to the evaluation process; field evaluation completes the picture.

d. FIELD EVALUATION:

(1) Internal evaluation of all components of the instructional system provides a basis for determining system effectiveness. But, even if internal evaluation reveals no fault in planning, developing, and conducting the instruction, there is no guarantee that the graduates will perform satisfactorily in the field. Field evaluation is also necessary. The purpose of field evaluation is to determine the ability of recent graduates to perform their assigned tasks to the level of proficiency specified in the applicable training standard.[1] If the graduates do not need what they were taught, or do need instruction they didn't receive, this information must be fed back to the instructional system designers. There may be a need to revise the instruction. If the graduates cannot perform some tasks sufficiently well, that may also indicate a need to revise instruction. Perhaps there wasn't sufficient practice during instruction to assure retention.

(2) The matter of retention of instruction warrants a special comment. In analyzing field evaluation findings, indications that the graduates have forgotten some of what they were taught should be carefully investigated. The instruction they received could be at fault, but there are several other possible causes relating to job conditions which should be assessed. The behaviors produced during instruction must be maintained in the job situation or else they will disappear. These behaviors will not be maintained on the job if the motivation does not exist, or if it is unrewarding or punishing to the graduate to continue to display them.[2] So, to properly evaluate the finding that the graduates haven't retained instruction, it is also necessary to know what happened to them *after* they completed instruction. Otherwise it is possible to mistakenly invest time, equipment, and money in "beefing-up" instruction that is not at fault (20).

(3) A field evaluation must be carefully designed and executed to assure the collection of accurate and valid data. The evaluation may be done through the use of mailed questionnaires sent to the supervisor, the graduate, or to both. It may be done through field visits by an evaluator during which the graduate's performance may be observed; or the graduate and his supervisor may be interviewed; or both observation and interview may be conducted. Finally, there is the controlled job performance evaluation made by observation of the graduate's performance over a specific period of time and evaluated and reported by his supervisor.

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[1] AFR 50-38, *Field Evaluation of Formal School Graduates,* establishes a program for evaluation of graduates of formal courses and career development courses, and prescribes the forms to be used.

[2] A few examples will indicate some of the many possible situations:

a. What the graduate learned during instruction, he is not permitted to apply on the job.

b. Some of the graduate's fellow-workers, who have not received the instruction he got, feel threatened. To preserve their good will toward him, he stops applying what he was taught.

c. The graduate, who learned how to do the task properly, finds that on the job others, who do a halfway job with much less effort, receive the same "rewards" that he does.

(4) Questionnaires offer the least expensive procedure for field evaluation and may be used to collect large samples of graduate information. However, questionnaires may not be the most reliable form of evaluation. The validity of the data obtained through the use of the mailed questionnaire tends to be proportional to how well it is prepared and distributed. Questionnaires should be tried out before general use to be sure that the recipient of the questionnaire understands the questions in the same way that the designer of the questionnaire does.

(a) Preparation. One of the most important features in the development of a questionnaire is the guidance given for its completion. Instructions should be clearly stated. Nothing should be taken for granted.

_1_ The main portion of the questionnaire consists of a list of task and knowledge statements, either extracted or paraphrased, from the instructional standard which is the primary control document of the instruction being evaluated. The supervisor of the graduate may be asked to rate him on his ability to perform each task listed in the questionnaire. A similar type of questionnaire could be sent to the graduate asking him to indicate how well he thinks the instruction equipped him to meet the requirements of his job. He could also be asked to indicate which tasks he does not perform.

_2_ For full utilization of the questionnaire technique of evaluation, supplemental "information-seeking" questions may be added. Such questions may ask for an estimation of the amount of time the graduate devotes to the individual tasks or duties within his Air Force Specialty (AFS). Other questions may ask about items of equipment, materials, or procedures used by the graduate. An open-ended question could be included asking for suggestions as to how instruction might be improved.

(b) Distribution:

_1_ Valid results from the mailed questionnaire are largely dependent upon the selection of the respondents. A representative sampling of the total number of graduates is essential. For any AFS, there may be variances in job requirements and utilization of graduates by major command, geographical location, level of organization, etc. The sample should allow for these possible sources of variation.

_2_ Proper timing of the distribution is also an important factor. Usually, questionnaires should be mailed to arrive at the base of assignment between 3 and 6 months after graduation. If more than 6 months elapse, it may be impossible to determine whether the graduate learned the skill or knowledge from the instruction, or acquired it by working on the job. On the other hand, if the questionnaire arrives too early, the graduate may have had time to perform only a few of the tasks listed in the questionnaire (2). An addressed return envelope should accompany the questionnaire so the student or supervisor can return the completed form, without review by higher authority, to the training system.

(c) Analysis of Returns. When the questionnaires have been returned, the task of evaluating the data obtained can begin. It is a process of compiling, collating, and analyzing the information from each command. Particular attention should be paid to written comments given freely, or elicited by the supplementary questions. Caution should be exercised in using data from questionnaires exhibiting obvious errors, such as the halo effect (the indiscriminate rating of all items positively) and central tendency (rating all items in the center of the scale—no discrimination made). Therefore, very careful consideration of the responses is necessary to assure, insofar as possible, that the information accurately reflects the opinions of the graduates and their supervisors. Carefully prepared, properly distributed, objectively executed, and critically analyzed questionnaires can provide constructive information relative to the:

_1_ ability of recent graduates to perform the specific tasks for which they were prepared.

_2_ specific nature of instructional deficiencies as shown by the graduates' performance.

_3_ details of the jobs actually performed by the graduates.

4 extent and specific nature of instruction not needed by the graduates in meeting requirements of the using agencies.

(5) Field evaluation visits are performed by personnel from instructional activities who are sent to visit a representative sampling of graduates approximately 3 to 6 months after their assignment on the job. The purpose of the visits is to obtain firsthand information on graduate assignment, utilization, and proficiency on the job, and to validate information obtained from questionnaires. Pertinent data are gathered through observation and interviews with both the graduate and his immediate supervisor (2).

(6) Although the evaluator (interviewer) is primarily concerned with ascertaining the graduate's proficiency, he is also concerned with how the graduate's skills are being utilized, how well he is progressing through on-the-job training, as well as other comparative and significant aspects of the total work environment. For this purpose, a list of supplemental questions, similar to those contained in a mailed questionnaire, should be used as a guide while conducting the interview with the graduate's supervisor. However, the interviewer can deviate from the planned sequence and generally fit the interview to the responses he obtains from the supervisor or graduate. An accurate and complete set of notes should be taken concerning the answers to significant questions, in addition to specific or implied comments.

(7) The third method for field evaluation is conducted jointly by instructional and using activities to determine the extent to which graduates meet using activity performance requirements. Job performance evaluation is conducted in the working environment at representative using command bases. In this type of evaluation, the supervisors of the selected graduates are required to rate their performance during the first 8 to 10 weeks of the graduates' assignment. The supervisor is requested to maintain a weekly record of the task or job to be rated, the frequency of performance, a time rating, and the equipment used. As in the other methods of evaluation, the applicable instructional standard provides the criteria on which the ratings should be based.

(8) The supervisor is requested to submit the weekly performance record for analysis to the applicable instructional activity. Particular attention must be accorded those returns indicating a lack of ability on the part of the graduate to perform specific tasks.

(9) At the conclusion of the performance evaluation, a return visit to the using activities should be made for the purpose of conducting a critique on the evaluation, to gather additional data, and to clarify any areas not clearly defined in the evaluation returns.

6-4. Summary:

a. To assure an effectively operating instructional system, it is not only necessary to develop validated, job-referenced instruction but there must also be planning and preparation for the implementation and maintenance of the instructional system. This will require training for instructors in their new roles and orientation for supervisors and managers in the supportive actions they must provide.

b. When the system becomes operational, it is necessary to conduct internal and field evaluations. The evidence collected during these evaluations must be examined to determine if the graduate is, in fact, capable of satisfying job performance requirements. This information becomes the feedback to instructional system personnel. The analysis of data obtained through internal and field evaluations should point out both strengths and weaknesses in the program. Properly conducted evaluation assures a steady flow of pertinent and timely information for use in maintaining the quality and cost-effectiveness of an instructional system.

CHAPTER 7

Application of ISD to Knowledges and Attitudes[1]

7-1. Introduction. Knowledges and attitudes exist to some degree in all instructional systems. It is the purpose of this chapter to describe how the ISD process and principles can be applied to design and evaluate instruction for knowledges and attitudes, either in a formal course or in a career development course (CDC).

a. For any type of program to which ISD is being applied, a base must be established from which instruction can be designed and evaluated. If what is to be learned cannot be defined, in measurable terms, it may not be possible to determine if it has been accomplished.

b. In many instructional systems, instruction is designed based on specifically defined and observable job tasks and related performance standards. In some ways it is more difficult to obtain this kind of information in areas dealing mainly with the learning of knowledges and attitudes. However, the requirement still exists, and a basis for designing and evaluating instruction still must be identified. Although there are some procedural differences in data collection, the basic process and principles of ISD are valid for developing instructional systems involving knowledges and attitudes.

c. Although there are other methodologies for designing instructional systems for knowledges and attitudes, this chapter is limited to a methodology considered one of the easiest to use.

7-2. Analyze System Requirements:

a. The first step in any ISD effort is an analysis of system requirements. Its purpose is to describe the nature and scope of man's expected role in the operational setting. This information then serves as a starting point for the design and evaluation of instruction.

b. A system analysis designed to gather the information necessary to begin instructional development for knowledges and/or attitudes involves:

(1) identification of the system needs;

(2) determination of instructional goals which (if accomplished) are expected to satisfy the needs identified; and

(3) identification of measurable behaviors for each goal which (if accomplished) will be accepted as attainment of the goals.

c. The purpose of ISD is to develop instruction which will satisfy the needs of the system when instruction is determined to be the appropriate solution. Needs are generated in many ways, some as the result of management directives inherent to the system, and others from observed discrepancies of desired versus actual behavior. For example, a system need for *better qualified managers* might be generated if low morale in an organization was attributed to management deficiencies. Regardless of their sources, system needs are the driving factor behind the initiation of any ISD effort.

d. Based on system needs, instructional goals are developed. Instructional goals describe the expected outcomes of instruction in terms of a broad or abstract intent, state, or condition (7). For example, *to improve the managerial skills of Air Force personnel* could serve as an instructional goal. Another instructional goal might be *to have managers be sensitive to the needs and problems of those they manage*.

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[1] For the purpose of this chapter, *knowledges* are defined as mental abilities (recalling facts, identifying concepts, applying rules, or solving problems, etc.) and *attitudes* as mental states or conditions which affect motivation and behavior.

e. Once the needs of the system (job) have been expressed as instructional goals, these goals are analyzed to arrive at measurable behaviors for each. These measurable behaviors are sometimes called indicator behaviors. The appropriate indicator behaviors can serve as acceptable evidence that the associated goal has been attained. In comparison to the basic ISD model (described in chapters 1-6 of this manual), these measurable behaviors serve the same function as job performance requirements.[2] In identifying such behaviors, a team of subject matter specialists (SMSs) is often consulted and asked to describe and agree on behaviors which can be measured, and which (if accomplished) would be considered an indication of achievement of the goal(s). It is often critical to verify these measurable behaviors with the using agencies and obtain concurrence that if these behaviors are performed, the system needs will be satisfied. It is also possible to further validate these measurable behaviors later during the evaluation of the instructional system by surveying graduates to determine the job-usefulness of the behaviors acquired during instruction.

f. An example of many measurable behaviors related to the previously mentioned goal on managerial skills might be to *write a long-range management plan*. It is the purpose of the instructional goal analysis to determine all of the measurable behaviors which a student would be required to exhibit in order to satisfy the goal. In some cases, one or two measurable behaviors might be sufficient while other cases might require many. Assume in this case it was determined through consultation with SMSs and the using agencies that what specifically is meant by the goal *to improve management skills of Air Force personnel* is that they be able to write long-range, mid-range, and short-range management plans. If performed, these three measurable behaviors would constitute attainment of the goal. In most cases, the analysis will not be this simple; however, the process is still the same.

g. In the second example of a goal, suppose that it was determined that for a manager to be sensitive to the needs and problems of those he manages he would have to: identify the possible needs and problems which could arise from his employees, be able to recognize manifestations of those needs and problems and prescribe the appropriate action for each situation. What started out to be largely an attitudinal type goal then becomes much more definable in terms of measurable behaviors which are largely based on knowledges. The attitudinal portion of the goal is still present, however, since it is conceivable that a manager might know how he is expected to act toward his employees without actually acting that way. To design instructional activities which actually do change behaviors of this kind presents a real challenge. In some cases, instruction on attitudes must be supported by contingencies and rewards built into the job. For example, if a manager is expected to be sensitive to the needs of his employees and yet there are no rewards or punishments as the result of appropriate or inappropriate actions, then the full worth of instruction may not be realized. It is important that personnel exhibiting appropriate behaviors are rewarded and not punished.

h. In another example, suppose the goal was *to understand the classic principles of war and their interrelationships*. After consulting with SMSs and using agencies, it is determined that what is really meant by understand the classic principles of war and their interrelationships is to recognize operational examples of each principle and for given situations, apply the appropriate principles. If performed, these two measurable behaviors would constitute attainment of the goal.

i. In any case, an agreed upon list of measurable performances would serve the same function as a list of job performance requirements.

7-3. Define Instructional Requirements:

a. To determine "what should be taught," each measurable behavior (whether it is an indicator for an attitudinal or knowledge type goal) is analyzed to determine what must be learned in order to perform that behavior. This process identifies the content from which instruction is to be developed and the types of learning[3] (table 5-1) which are involved.

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[2] For an elaboration on the process of identifying measurable behaviors see *Goal Analysis* by Robert F. Mager (7). Another related method of identifying behaviors to serve as the basis of instruction is described by Gronlund (23).

b. Returning to the measurable behavior used earlier *to develop a long-range management plan*, an analysis would reveal that this behavior requires a student to recognize such a plan before he could write one. *To identify long-range management plans* then would be a learning requirement for this behavior and be classified as a concept classification task according to the types of learning in table 5-1. Besides determining what should be taught, this kind of analysis provides valuable information in developing and sequencing objectives, tests, and instructional activities. (This will be discussed in more detail later.)

c. Once the measurable behaviors have been analyzed to determine the specific content of instruction, and the types of learning to be acquired are identified (problem solving, rule using, etc.) the objectives and tests can be developed and sequenced.

7-4. Develop Objectives and Tests:

a. The learning requirements identified for each measurable behavior and the associated type of learning is used as the basis for writing objectives and tests. The classification of the types of learning is an important factor since the different types require certain conditions to be stated in their objectives which impact on their associated test items. The most critical conditions are for classifying, rule using, problem solving and exhibiting desirable attitudes and opinions as shown in table 7-1. For example, the learning requirement to identify long-range management plans would be classified as a concept classification task; according to table 7-1, an instructional objective for this task should read something like the following: Given examples of long-range management plans and nonexamples[4] which have not previously been presented, correctly identify each.

b. The purpose of the condition to present examples and nonexamples which have not been presented before is to be sure that the student has not merely remembered or memorized specific examples and/or nonexamples of the concept during instruction. If memorization of specific example(s) of a concept is all that is desired, then the task is, and should be classified as, forming associations. If, however, the student is expected to correctly classify an example of a concept in many or all situations, then it is a concept classification task and appropriate conditions listed in table 7-1 should be controlled.

c. The same rationale applies when explaining the purpose of the conditions listed for rule using and problem solving. If an objective is written at the rule using or problem solving level, it must be tested at the same level. To be sure that a student is not memorizing the application of a rule to only one situation, or in the case of problem solving, memorizing the solution to one specific problem, tasks presented in the test situation should not have been previously encountered by the student.

d. One way to evaluate the previous objective would be to specify examples and nonexamples of long-range management plans to be presented to students for correct identification. If an "in-depth understanding" of the concept is desired, the examples and nonexamples can be increased in their complexity. That is, the nonexamples might be very similar to examples of the concept, differing only on one critical property; or the examples themselves might be made so complex that it would be difficult (but not impossible) to determine if they actually contained the critical properties necessary to make them examples. If the objective is tested at this complexity, however, the examples and nonexamples used during instruction should also be at the same difficulty level.

e. In writing an instructional objective for a task which requires a voluntary act, thus expressing an attitude or opinion, it is important to include the condition that the students will not know when they are being evaluated on the desired behavior.[5]

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[3] Other learning taxonomies being used with varying degrees of success include Gagne (22), Merrill (8), and Bloom and Krathwol (23).

[4] A nonexample is defined as anything which would not be classified as an example of a given concept. To be useful the nonexample should contain similar irrelevant properties of the given concept but lack one or more of its critical properties.

[5] Procedures described for testing and designing instruction for attitudes or opinions are adapted from *Selecting Instructional Strategies and Media: A Place to Begin* by Merrill and Goodman (24).

Table 7-1. Critical Conditions for Several Types of Learning

Type of Learning	Critical conditions to be included in the objectives and controlled in the test items.
Making Classifications (classifying concepts)	The examples of concepts given should not have previously been presented. Also, to control for finer discriminations, nonexamples of the concept should be presented which have not previously been encountered.
Rule Using	The situations to which the rule is to be applied should not have previously been encountered.
Problem Solving	The specific problem to be solved should not have previously been encountered.
Exhibiting Desirable Attitudes and Opinions	A behavior consistent with or opposed to the desired attitude or opinion must be presented and the student's choice observed without his being aware and without cues being provided as to the desired choice. (For three levels of evaluation which are possible, see text.)

For example, an instructional objective for exhibiting an attitude or opinion might be written as follows: Without knowing their behavior is being observed, cadets will demonstrate respect for the flag during retreat by properly saluting.

f. In testing for attitudes or opinions, it is important to provide a choice for the student between a behavior(s) consistent with and opposed to the desired behavior and not to provide cues to the desired choice.

g. Attitudes or opinions may be evaluated at three levels to varying degrees of success. Level one involves expressing acceptance or nonacceptance of the stated attitude or opinion; level two requires the student to respond how he/she would act in a described situation involving the desired attitude or opinion; and level three is an observation of the student's behavior in an actual situation.

h. The first two levels can be more readily faked than the third. However, it is sometimes difficult in an instructional setting to recreate a real world situation, and approximations to the actual situation must be used. Regardless of the level of evaluation, it is crucial that the students not know they are being tested on their attitudes or opinions.

i. Once the objectives and tests are developed, they should be organized and sequenced into units and lessons. This may be accomplished according to the types of learning, actual job sequence, or a combination of these. After this is done, it is often beneficial to administer the tests in the appropriate sequence to those for whom instruction is being designed, and to those considered experts in the area, or representative of the desired attitudes and opinions. This process validates the tests and also provides a check on the selection of instructional requirements and, indirectly, the measurable behaviors, since the instructional requirements were derived from them. For example, the experts would be expected to pass the tests and the target population of the course would not. There probably will be exceptions, but if there is a substantial difference from the expected trend, then further analysis is needed on the tests or the instructional requirements and measurable behaviors; perhaps even the instructional goal should be reexamined.

7-5. Plan, Develop, and Validate Instruction:

a. Based on the types of learning associated with the objectives, the appropriate instructional activities are developed. Ample guidance is provided in AFP 50-58, volume IV, chapter 3, 15 July 1973, to accomplish this activity for knowledges.

b. One method of designing and developing instruction for the previous classification objective on long-range management plans requires that a clear statement or definition of a long-range management plan be prepared; the definition should specify the critical properties which cause a plan to be classified as being a long-range management plan.

c. Next, a file of examples and nonexamples of long-range management plans is compiled. These examples and nonexamples may be selected, based on the degree of understanding desired as the result of instruction. The examples and nonexamples to be used during instruction should not appear in any of the tests.

d. While the example and nonexample file is being developed, feedback to the student should also be developed to explain exactly why each example "is one" and why the nonexample "isn't one." This information provides the core of the instruction and highlights the critical properties of the concept which must be learned if the objective is to be accomplished. Usually, concurrently with development of the previous material, the method of instruction and media to be employed should be determined. For example, the method of instruction might be self-pacing and the medium might be a written workbook. In the situation described, the student may be given a workbook with a pretest consisting of examples and nonexamples of long-range management plans. If he passes the pretest, he can proceed to another objective. If the student chooses not to take the pretest or fails it, the workbook would then present him/her with the definition of the concept, long-range management plans. It might even provide additional explanatory material on this definition, written in different words or in more detail.

e. After reading the definition, the student is directed to the examples and nonexamples of the concept. If he is not sure why one is an example and another one not, further information is provided to explain why and highlight the critical properties of the concept. The student is given the option of seeing as many examples and nonexamples as desired (or provided) with the option to take the final test at any time he feels he has mastered the concept.

f. The foregoing is only one method and many variations could be used, both in terms of methods of instruction and the media used. For example, an instructor could provide a lecture designed in a similar manner, stating the definition of the concept and then providing examples and nonexamples and entertaining questions concerning them. Some student response systems would be well suited for this method of programmed lecture.

g. Designing instruction which actually changes attitudes or opinions is a very challenging task. Following are some suggestions which may be helpful:

(1) Attitudes and opinions usually require a certain amount of knowledge to be learned before a student can rationalize a given attitude or opinion; therefore, it is important that the prerequisite knowledge be identified and instruction be provided according to the appropriate levels of learning (24).

(2) Human modeling has been used successfully in changing attitudes or opinions (22). This method requires someone whom the student respects and can identify with (a human model). The human model then actually exhibits the attitudes or opinions to be acquired by the student. This method can be meshed into the instruction presented on the prerequisite knowledges.

(3) Attitudes or opinions may be changed by designing role-play or simulation situations in which it is more pleasant for the student to adopt the desired attitude or opinion than to retain a currently held attitude or opinion (24). The unpleasant and pleasant experiences can be provided by group pressure or a reward system built into the situation.

(4) Group discussions which help the student examine the consistencies and inconsistencies of currently held attitudes or opinions may cause the desired change (24).

(5) It is important to avoid specific situations during instruction that are intended to be used in evaluating whether or not the student has adopted the desired attitude or opinion; this helps alleviate the possibility of a student remembering how he ought to act rather than how he feels (24).

7-6. Conduct and Evaluate Instruction. Procedures for evaluation are contained in chapter 6 of this manual and in AFP 50-58, volume V. A continuing system of modification and evaluation will include questions such as: "How well has the course been taught?" "Are we accomplishing what we intended to do?" and "How can we improve the course?" Finally, "Is the instruction satisfying the system needs for which it was designed?" The answers to this final question, which usually can best be answered by the using agencies and the monitoring staff elements of HQ USAF, provide the final step in the validation process. The information obtained is the information needed to validate the instructional goals as previously described. When the instructional goals are modified, based on information such as this and information obtained from students and instructors, the ISD process is repeated through the five steps again, as necessary.

7-7. **Knowledges and Attitudes Encountered in Performance-Based Systems.** When knowledges and/or attitudes are to be learned in performance-based instructional systems, the process of designing instruction for them is the same as previously described in this chapter. In performance-based systems, however, knowledges and/or attitudes are identified as the result of analyzing observable job performance requirements into their component parts. Whereas, in knowledge-based systems, the knowledges and/or attitudes are derived from an analysis of the instructional goals and their measurable behaviors. Once knowledge and/or attitudes are identified as being a learning requirement, they should be classified as to their type of learning, and objectives, tests, and instruction be developed in accordance with the procedures previously described in this chapter and in AFP 50-58, volumes III and IV.

7-8. Summary. In conclusion, ISD can be applied to knowledge and attitudinal subject matter. In comparison to the basic model described in chapters 1-6, there are some procedural differences in data collection but the same principles of ISD are applied. The following summarizes the steps involved when applying ISD to knowledges and attitudes: develop instructional goals from system needs; analyze instructional goals to determine measurable behaviors which, if performed, will satisfy the goal; analyze measurable behaviors to determine instructional requirements; develop objectives and tests from the instructional requirements; plan, develop and validate instruction; and conduct and evaluate instruction.

CHAPTER 8

Air Force Flying Training

8-1. Introduction. The ISD process and model have been described in detail in the preceding chapters. The purpose of this chapter is to provide supplementary information of interest to personnel planning or performing ISD of flying training courses.

a. ISD combines principles of instructional design and management engineering. In application, the management engineering assumes a larger role with an increase in organizational size and complexity. ISD of flying training represents such a problem. The objectives of this chapter are to:

(1) address those characteristics of flying training ISD which cause it to differ from other ISD efforts; and

(2) discuss some methods for resolution of problems caused by these characteristics.

b. The following listed items are indicative of those characteristics which make ISD of flying training different:

(1) the number and complexity of job task items;

(2) mission role diversity;

(3) inherent danger associated with flying training;

(4) the high degree of responsibility placed on aircrews for safe mission accomplishment;

(5) the broad functional interface between operations and functional support agencies;

(6) use of special media devices (for example, aircraft, simulators, instrument trainers, procedures trainers, etc.);

(7) high cost of equipment/resources;

(8) high operating and maintenance cost;

(9) training conducted under various weather conditions;

(10) the volume of regulatory constraints (regulations, manuals, checklists, policy);

(11) incompatability of civilian skills with military flying skills necessitating training in each task; and

(12) the ISD products which must be developed (course training standard, syllabus, etc.).

c. Although it is by no means a complete list, these characteristics are considered to be representative of most flying training courses and should serve as an initial point of departure for discussing flying training ISD. The management problems created by these characteristics impact on instructional design. Such impact may require substantial tradeoffs between learning effectiveness and practical working constraints during development and implementation. The remainder of this chapter will deal with those factors which influence successful applications of ISD in flying training curricula.

8-2. Identification of Goals and Initial Planning. Establishment of instructional goals and development of a plan to achieve those goals are prerequisites for successful ISD of flying training courses.

a. GOALS. The goals of instruction are to train or educate a specified number of individuals to perform specific job requirements. Limits may be established on the time and resources available to develop instruction using ISD methodology. Policy and guidance constraints also tend to restrict the designer's latitude for manpower, funding, etc. The goals for ISD are the criteria against which the ISD curriculum is evaluated. Goal statements should be specific enough to clearly define the goals but general enough to avoid unnecessary design constraints which inhibit goal achievement.

b. ISD APPLICATION PLAN. Goals alone do not provide an adequate base from which to accomplish ISD. A plan must be developed and coordinated to ensure that orchestration of effort is achieved with order and reason but without unnecessary duplication or oversight. At unit level a formal plan may be unnecessary. At higher levels (MAJCOM, air division, etc.) a formal plan is essential in order to establish the authority, tasking, working relationships, etc. A good plan for ISD may contain the following items of information:

(1) purpose of the plan;

(2) ISD goals and constraints;

(3) directing authority;

(4) concept of operations;

(5) tasking (including establishment of any special organizations, study groups, working groups, etc.);

(6) policy and guidance for the ISD effort;

(7) working relationship between agencies (if unusual in nature);

(8) initial milestone completion dates;

(9) implementation date of the ISD curriculum;

(10) products and documentation to be delivered as part of the ISD package (CTS, syllabus, data bank, decision rationale, etc.); and

(11) training concepts to be employed.

c. ISD PRACTICAL WORKING CONSTRAINTS. Some guidance is necessary regarding ground rules for resource usage. This guidance should come directly from the directing authority in writing to avoid any misunderstanding. The specific type of guidance which may be provided is beyond the scope of this chapter; however, a few examples should be sufficient to raise issues relevant to a particular ISD effort.

(1) *Manpower.*

(a) What manpower ceilings are imposed?

(b) What manpower resources are available to draw from?

(c) What skill levels are required?

(d) Will training be necessary to meet skilled personnel requirements?

(e) What will be the student load?

(2) *Resources/Equipment:*

(a) What resource/equipment utilization constraints are imposed?

(b) What equipment is available for this ISD curriculum?

(c) Is any new equipment programmed for the future (for example, new aircraft type, radar, ejection seat, advanced simulator, etc.)?

(d) What funding limits are imposed for any additional equipment which may be needed?

(3) *Facilities:*

(a) What facilities will be available for training use?

(b) What new construction or modification to existing facilities is pending?

(c) What funds are available for additional needed construction/modifications?

(d) Has consideration been given to support facilities (for example, quarters, messing, alert, weapons storage, hangars, ramp space, etc.)?

(4) *Regulations:*

(a) What regulatory documents are applicable?

(b) Are these subject to waiver if required for training effectiveness?

(5) *Policy/Guidance:*

(a) What is the basic training philosophy?

(b) What training concepts are acceptable? Which are not?

These examples are only a few of the questions which should be raised in order to further define ISD working parameters. It is advantageous to identify these early in the development to avoid futile expenditure of time and effort.

d. LONG LEADTIME ITEMS:

(1) Acquisition of long leadtime items often requires premature identification of quantitative and qualitative resource requirements. The ISD process should identify exactly what is required in terms of numbers of instructors, instructional equipment, and facilities. Unfortunately, the time between full knowledge of media/resource requirements and the scheduled implementation of the new curriculum may be less than that required to obtain essential resource items necessary for implementation. Delaying implementation to obtain desired media/resources may be impractical or even impossible. Sometimes instructional decisions must be made earlier than desired, and based on less than complete information in order to ensure availability of required training support items when they are needed. Seldom is this an easy task. All relevant information must be carefully weighed, and the final decision based on the best information available at the time the decision is made. Often this means delaying the decision until the last moment which offers reasonable assurance of timely acquisition of needed items. Since this point is somewhat elusive, it is helpful to establish milestone dates for major stages of development, such as initial design; requests for proposals (RFP); source selection; delivery; testing; maintenance, supervisory, and instructor training; and courseware validation. While all of these may not be necessary or in this order, there should be enough differentiation at the various acquisition stages to allow managerial control through management by exception. As these milestones are passed and the ISD progresses, additional system requirements data will surface. This new data may be used to revise and update earlier system requirements estimates and to initiate new acquisition or modification requests. In this manner long leadtime items develop concurrently with instructional design and allow timely ISD implementation.

(2) Particular interest should be given to items such as buildings, ramp space, runways, automated data processing, special training devices, and manpower requirements.[1] The office of primary responsibility (OPR) for the type of resource or support required should be able to provide all the necessary data pertinent to planning, procurement, and/or construction of these resources. For example, the civil engineer should provide information for building construction or modification, ramp space additions, etc., while plans and requirements should be able to provide information regarding acquisition of special media devices such as simulators, instrument trainers, etc. These examples illustrate the coordinated management effort necessary to obtain resource/support requirements for ISD of flying training courses.

e. DATA AUTOMATION SUPPORT. Automated data processing (ADP) has many potential applications in large-scale flying training ISD efforts. It is useful for data handling and simulation modeling during course development as well as for student/resource scheduling and administrative records keeping during implementation. The following paragraphs provide a brief description of these ADP applications to acquaint the instructional designer with advantages and disadvantages of each.

(1) *Data handling:*

(a) In small ISD efforts, manual data handling is usually adequate. However, ISD of flying training courses involves such a volume of task analysis data that manual data handling may not be capable of providing desired support. In this case, ADP may be the only acceptable alternative. In practice, task analysis data must be observed, recorded, sorted, indexed, stored, and selectively retrieved in a useful, coherent form. ADP can perform most of these operations routinely without many disadvantages inherent to human systems. Since task analysis data is compiled early in the ISD process, any ADP services desired must be identified in time to allow for their availability when needed. AFM 300-6, AFM 300-12, and AFR 300-2 provide information for obtaining ADP services.

(b) Desirable ADP characteristics for handling task analysis data are a flexible indexing system and a large storage capacity. Regardless of the indexing system used, it should be compatible with the ADP equipment available, and it should cross-reference task items with the respective objective, test, function, equipment, procedure, knowledge, or decision to which they relate. A well-designed index system will allow expansion and introduction of new task data and will facilitate commonality analyses during courseware development.

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[1] In considering manpower requirements, the need for ISD-trained personnel and stability of assignment for such personnel should not be overlooked.

(2) *Modeling:*

(a) An ADP model for simulating the instructional system may be constructed if sufficient system data is available. Such a "simulation model" allows analysis of system operation in terms of a defined set of input factors without the expense involved with actual construction and operation of the "real" instructional system. Use of the model permits the designer to analyze system resource utilization and cost factors. Such analysis may not be practical by any other method. Successive interactions with various media and/or sequence option inputs yield information which leads to the most cost-effective instructional system possible under the defined constraints. Though the benefits of this kind of modeling are great, there are inherent disadvantages as well. Simulation modeling requires detailed information of instructional system constraints, including system component interrelationships. These relationships are not always known, nor do they always remain constant with time; therefore, it is sometimes necessary to make assumptions regarding them in order to "operate" the model. When this is done, it should be kept in mind that output data reflects the inaccuracies of any erroneous assumptions.

(b) The more closely the model simulates the job-world constraints which it portrays, the more accurate and reliable the output. Further, the expense of identifying and quantifying all the instructional system variables and their interrelationships may be prohibitive. Thus, this kind of simulation modeling may not be practical except in very large ISD efforts involving extremely high cost resources. The intent here is to identify potential ADP uses. Their application must be tempered with judgment based upon an understanding of the potential benefits and anticipated costs in time, manpower, and resources.

(3) *Scheduling.* In large systems, resource utilization presents a significant problem. The goal is to maximize resource utilization. While a single scheduling problem may be manually resolved with minimal effort, a large-scale scheduling problem involving many students and instructors, media, etc., may make manual scheduling impractical. ADP offers the capability to solve most scheduling problems quickly and according to specified constraints. Although the computer may be able to resolve most scheduling problems, some special problems for which the computer is not programmed may remain. These special problems revert to manual scheduling for resolution. Programming these special problems may involve complex constraints which represent costs disproportionate to the benefits expected. In summary, ADP scheduling is possible. The factors which influence the decision are numerous and complex. The benefits must be weighed against the expected costs for ADP services.

(4) *Administrative record keeping:*

(a) One of the fallout items from ADP scheduling is the data concerning student progress and resource utilization. In the case of student progress, ADP is capable of keeping realtime records of student achievement. With ADP such data is quickly available to aid in counseling and/or manual scheduling. ADP can relieve the instructor of time-consuming "bookkeeping" and permit him to devote more attention to instructional rather than clerical tasks.

(b) ADP equipment may be programmed to summarize resource utiliaztion in such a way that course training managers can identify resource excesses and deficiences. This information assists management in justifying and obtaining needed additional resources, and allows excesses to be employed elsewhere. Further, it provides an indication of maximum student load capability based on resource constraints, and identifies additional resources necessary if student loads increase beyond programmed levels.

(5) *ADP summary.* ADP provides capabilities which enhance ISD development and implementation, yet, ADP support may be difficult to obtain due to the expense involved and the competitive nature of computer time allocation.

Requirements must be identified early and sufficient justification provided to confirm ADP support needs. Unfortunately, the leadtime required to develop and test computer programs is often in advance of full knowledge of system operating constraints. This forces delays for reprogramming and further testing. The instructional designer can aid in resolution of this problem by working closely with the programmer during development of data support systems.

8-3. Media:

a. MEDIA DEVICES. Flying training courses traditionally have employed special types of media devices to enhance learning effectiveness as well as to reduce training costs and exposure to risks inherent in actual flight. Certainly the aircraft is a preferred media for criterion performance and may be required for much of the instruction. Yet often the instruction is effectively (sometimes more effectively) taught with less expensive devices. Often the aircraft is not the ideal training vehicle. Safety factors, high operating costs, and an undesirable physical and psychological environment (noise, uncomfortable temperature, undue stress, etc.) often make alternative devices more attractive, in terms of cost and/or effectiveness. A prime example is a realistic simulator in which hazardous, but necessary, procedures may be practiced, repetitively, without risk. The designer's task is to design the instruction to use the appropriate media which will accomplish the necessary training in the most cost-effective way. Thus, by selective media usage, the instructional designer enhances both learning effectiveness and economic efficiency. Invariably, some tradeoffs will be required during media selection; however, the only acceptable media will be those which meet instructional objectives. From among these, the instructional designer should select the medium which represents the most cost-effective alternatives. More attention is devoted to media selection in the following paragraphs.

b. SELECTION OF MEDIA:

(1) Media requirements are determined for each objective based upon the medium which offers the greatest learning transfer capability. In addition, media alternatives are identified for comparison and possible tradeoffs between effectiveness and economy. Often it is necessary to subjectively quantify learning effectiveness for a media/objective combination. This value, coupled with estimates of time to learn the desired information or skill using that media, and estimates of media utilization costs, yields data regarding the cost of teaching a specified objective by various media. This process provides a quantified basis for media decisions; however, it does not make the decision. The data obtained from this type of analysis is only as reliable as the learning effectiveness, learning time, and cost estimates; therefore, managerial experience and other intangible factors weigh heavily on the final decision. The question which must be addressed is whether the time spent in such analysis is worth the potential cost saving which may develop from the analysis. While this type of analysis offers potentially useful information, the validity of the data may be questioned because of its subjective base. Still, it may provide the only quantified base for managerial discrimination between various media/cost/benefit alternatives.

(2) When media types have been assigned to each objective, the media requirements list should be consolidated to identify qualitative and quantitative needs. A comparison between the consolidated ISD media requirements list and the list of media devices already available identifies items which must be procured. Should it be impossible (for whatever reason) to procure equipment needed, the instructional designer must reevaluate the instruction and identify alternative equipment (if possible) capable of supporting instructional objectives and related knowledges or skills.

(3) Often media selection is restricted to what is presently available. This is not always desirable from an instructional design point of view since it may impact directly on learning effectiveness; still, it is a realistic economic approach, and a common practice. It makes sense to determine if instructional objectives can be met using "on board" equipment/facilities (including those which can be economically modified) before investing in expensive new equipment.

c. MAINTENANCE. Most media devices require occasional preventive maintenance; yet, in spite of these precautions a few will suffer untimely breakdown. This should be expected and planned for.

In some instances, spare equipment may be employed pending repair or replacement of the malfunctioning equipment. If the item is expensive, it may be impractical to have a spare. In this case, maintenance and repair service planning should allow for "downtime" during which the equipment can be worked on without interfering with instruction.

d. TESTING:

(1) Most flying training objectives are tested in the aircraft. Others are tested in the media which offers assurance that the task could be performed in the aircraft, if necessary. A good example is the ejection procedure in many aircraft. Performing a practice ejection in a real aircraft is unthinkable. Thus, for safety and economy considerations, the ejection procedure is practiced and the test administered in another media, such as a cockpit simulator or ejection seat trainer. Naturally, the reality of the canopy departing the aircraft, the windblast, and the kick of the charged seat may not be realistic, but the procedural actions preparatory to actual ejection are identical to those required in the aircraft and they are the critical aspects which must be learned. There are other similar situations such as engine-out approaches, engine fire, loss of cabin pressure, etc., which fall in this category. Simulated tests offer not only a safer environment; often, they provide a better and less expensive learning environment. For example, the instructional sequence may be stopped at any point during simulation for clarification or additional practice, as required, then re-initiated. Since this can not be done in the aircraft (criterion media) for either economy or safety reasons, the simulated environment is often more effective in certain learning/testing situations.

(2) As stated previously, the intent in applying ISD is to develop quality training at least cost. To achieve this goal, the instructional designer must carefully weigh advantages and cost of media usage for each objective. Selection of the proper media for instruction or testing requires answers to pertinent questions such as the following:

(a) What media best suits the objective?

(b) What alternatives exist?

(c) What is available locally?

(d) What is the cost of operating and maintaining these media?

(e) How long a leadtime is needed to obtain proposed media? Develop courseware? Train instructors, operators, maintainers?

(f) How much instructional time is required using the primary media proposed? Secondary?

(g) What cost differential exists between media alternatives?

(h) What are the costs for manpower, supplies, program development?

(i) Are the proposed media compatible with other courseware with which the media may be used?

(j) Are media (device) repairs/parts available locally? Spare units?

(k) What storage or special handling requirements are necessary?

(l) What type of training is required to operate? Maintain?

(m) Is other equipment necessary to use these media?

(n) Where can the objective be tested?

(o) What tradeoffs are necessary if a different medium is used?

(p) Are safety factors observed in these media?

(q) Is it realistic?

(3) These questions are only samples of those which must be considered if the most cost-effective media selection is made. The questions will vary based on the working constraints imposed upon media usage. The process becomes easier with application and experience since prior research regarding media capability, constraints, cost, and availability reduce the amount of additional work necessary in many cases. Still each medium/objective combination must be individually selected to ensure that the instructional objective is satisfied in the most cost-effective manner.

8-4. Application of ISD Process:

a. IMPACTS:

(1) Flying training is a direct mission support function. As such, it enjoys a broad functional area interface with other mission support functional areas. Consequently, any alterations in flight training methods usually affect support requirements. Similarly, changes in functional support capability usually result in a corresponding change in mission effectiveness. Occasionally a minor change in either area will produce dramatic impacts to mission capability. Thus, it becomes essential that all training innovations or support capability changes be coordinated in advance to avoid adverse impacts to respective functional support areas as well as to the mission effectiveness.

(2) ISD of flying training offers many opportunities to introduce innovative concepts, methodologies, etc., which improve training, but which also change the character of the course immensely. The impacts are not always known, and even when they are known, their effect on mission capability is not always predictable. One solution to this problem is to establish an interfunctional area working group to assist with recognition and resolution of potential impacts. The working group is particularly useful to the ISD effort in the initial stages of Step 1 (Analysis of Systems Requirements) since group members are able to provide expertise and known constraints peculiar to respective functional areas (for example, maintenance, logistics, personnel, etc.). This aids in establishing ground rules for further ISD. In addition, many unanticipated problems occur during implementation. The working group is able to assist in resolution of these problems with minimum impact since all functional areas are represented.

(3) In practice, the working group must play an active role. Their individual and collective contributions are essential to successful implementation of the ISD curriculum. Working group participation often promotes understanding and support of ISD and aids the working group representatives in recognizing and addressing potential functional area impacts within their areas.

b. DOCUMENTATION:

(1) The survivability of an ISD curriculum is directly related to the supporting documentation. The documentation acts as a baseline for evaluation of proposed curriculum changes. To be effective, documentation must include all pertinent factors which influenced a training decision, including facts, assumptions, majority and minority opinion, and the name of the individual who actually made the decision. This precludes a requirement to perform a second detailed analysis of the decision rationale and provides a valid comparison between the relative merits of existing and proposed training solutions.

(2) Documentation of ISD efforts in flying training is involved and time-consuming; yet, it is essential for ISD curriculum continuity following implementation. As an area of recent ISD interest and application, little information is available concerning problems characteristic to ISD of flying training courses. The more documentation that is available, the clearer the definition of the types of problems which may be anticipated in flying training ISD efforts, and the more successful the solutions to these problems. In this respect, continuity of the ISD curriculum is maintained by a self-refining process founded on documentation of factual ISD data.

(3) For reasons of ISD training effectiveness and continuity over the long term, the importance of adequate documentation is so great that one cannot afford to ignore it.

c. PRODUCTS:

(1) A full ISD effort will result in numerous products which have applicability to management, course control, and training personnel. The products which receive the most exposure are those directly related to the training for which the effort was initially undertaken. These may include such items as:

(a) job performance requirements.

(b) training requirements.

(c) course control documents.

(d) courseware:

_1_ instruction guides (lesson plans).

_2_ student study guides.

3 student workbooks (programmed texts).

4 learning center instructional packages, etc.

(e) implementation plan.

(2) In addition to these examples, other valuable ISD byproducts may include the following:

(a) task analysis data bank.

(b) target population data.

(c) courses which support part or all of certain job performance requirements.

(d) media selection rationale.

(e) personnel/resources justifications.

(f) ISD documentation.

(3) Products which support an ISD curriculum should be stated in ISD (behavioral) terminology. So stated, there is a direct relationship between the curriculum and the product which addresses instruction to meet precisely stated training requirements. For example, in existing course training standard (CTS) terminology there is some degree of vagueness. This is not conducive to quality training since it is subject to interpretation by both the trainer and user of the product. CTSs stated in ISD (behavioral) terms do not allow the interpretation latitude of existing CTSs; therefore, the communication between trainer and user is more precise and useful as a common ground. This aids the user with identification of training deficiencies and the instructional designer (trainer) with resolution of training problems which caused these deficiencies. Figure 8-1 shows an extract from a "standard" flying training CTS. Compare this with the example of ISD CTS shown in figure 8-2, and note the advantage of the latter.

8-5. Summary. ISD of flying training courses uses the same process and model as other ISD efforts; however, due to the size and complexity of flying operations, certain management problems assume larger proportions. Resolution of these problems begins with definition of training goals and the development of a plan designed to meet those goals. Maximum use of all available management tools in a coordinated working environment reduces the ISD problem to more realistic and manageable proportions. The lessons learned from ISD efforts, if properly documented, support ISD curriculum continuity and serve to further applications of ISD to current and future flying training courses.

d. Formation flying techniques and procedures:

TWO-SHIP (day & night)	LEAD	WING
(1) Ground operations	3	3
(2) Takeoff, climb, leveloff	3	3
THREE & FOUR-SHIP (day only)		
(13) Takeoff, climb, leveloff	2	3

Level of proficiency:

"3" Performs in an essentially correct manner. Recognizes and corrects errors. Can apply knowledge gained to new or related job elements. Requires normal supervision.

Figure 8-1. Extract from Course Training Standard (CTS) Using Code Key

	PERFORMANCE	CONDITIONS	STANDARDS
XII. PILOTAGE/DEAD RECKONING NAVIGATION	A. Perform pilotage/dead reckoning navigation.	1. VFR flight mission at a planned altitude between 10,000 and 15,000 feet MSL (not in APC). 2. Preplanted route on ONC map. 3. Preplanned airspeed between 300-450 KIAS. 4. Route length at least 250 NM, with 3 to 5 intermediate checkpoints. 5. Completed AF Form 70.	1. NA. 2. Maintains course ±5 NM. 3. ±20 knots of planned airspeed. 4. Reach each checkpoint and position aircraft within a 5-mile radius; arrive at final checkpoint ±3 minutes of preplanned or amended ETA and within ±100 pounds of estimated or revised estimate of fuel remaining. 5. As soon as practicable after passing each en route fix, record actual time of arrival for the fix, actual fuel remaining at the fix, and estimated time of arrival for next fix.
XIII. FORMATION TAKE OFF	A. Perform two-ship formation takeoff as lead. (Same as single-ship except for Conditions and Standards shown.)	1. Day only. 2. Runup and takeoff are from center of downwind side of runway. 3. Monitors wingman.	1. NA. 2. ±25 feet from center of downwind side. 3. Ensures wingman safely airborne prior to gear retraction.
	B. Perform two-ship formation takeoff as wingman.	1. Position is on fingertip line defined with respect to aircraft features for takeoff. 2. Configure aircraft with lead for the climb.	1. 25′ wingtip spacing stacked level until gear retraction; ±10 feet lateral spacing; longitudinal positioning from line abreast to one-ship length between lead's tail and wing's nose; vertical, high +0 to low −10 feet. 2. Maintains spacing as specified for takeoff. 3. Reaches fingertip position within 15 seconds after gear and flaps are retracted.

NOTE: Other "conditions," such as "performed using dry runway of at least 8000 feet," "15 knots surface crosswind limitation," etc., are specified in general portion of the standard.

Figure 8-2 Extract from Course Training Standard (CTS) Without Code Key

CHAPTER 9

Air Force Technical Training

9-1. Introduction. The ISD concept described in the first six chapters of this manual applies to the development and design of all Air Force education and training programs. The purpose of this chapter is to relate the process specifically to technical training. Technical training is Air Force specialty (AFS) oriented, and this affects the application of Steps 1 and 2 of the ISD process; therefore, the information in this chapter is limited to these two steps.

9-2. Analyze System Requirements. The application of the first step of the ISD model to technical training begins with a general description of the operational system and concludes with the documentation of specific job tasks and related data. The entire analysis is directed toward determining the human role in the operational system—a role described in terms of duties and tasks necessary to perform operational system functions such as control, operate, and maintain.

a. IDENTIFICATION AND ORGANIZATION PROCESS. The process of identifying and organizing these duties and tasks requires the accomplishment of the following activities:

(1) Identify operational system factors such as mission, operational policies and procedures, major components or items of equipment, and functions.

(2) Identify job performance requirements of the operational system.

(3) Develop an inventory of valid job duties and tasks and supporting data.

b. IDENTIFY OPERATIONAL SYSTEMS FACTORS. The paragraphs on "SOURCES OF INFORMATION FOR SYSTEM ANALYSIS" in chapter 2 provide adequate coverage of this activity.

c. IDENTIFY JOB PERFORMANCE REQUIREMENTS. As explained in chapter 2, the identification of job performance requirements is one of the most critical activities in the ISD process, since the tasks and related data form the basis for the remaining actions in the ISD process.

(1) Because technical training is Air Force specialty oriented, job performance data are collected and grouped according to the structure of the Military Personnel Classification System described in AFM 35-1.

(2) Typically, the identification, organization, and analysis of job performance requirements information is accomplished from the general to the specific in an order similar to figure 9-1.

(3) As previously mentioned, the first activity in Step 1 of the ISD process is to describe the operational system. The second major activity is the identification of the job performance requirements. As the major job duties and tasks are identified, there is a need to determine which Air Force personnel should perform them. This involves matching the duties with the career field summaries (a few examples of these summaries are shown in figure 9-2) and then the duties and tasks with the AFSs within those career fields (figure 9-4 shows an Air Force specialty summary and specialty description[1]). Occasionally, some of the duties and tasks will not match up with any

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[1] Descriptions of the existing Air Force specialties are contained in AFM 36-1, for officer personnel, and AFM 39-1, for enlisted personnel.

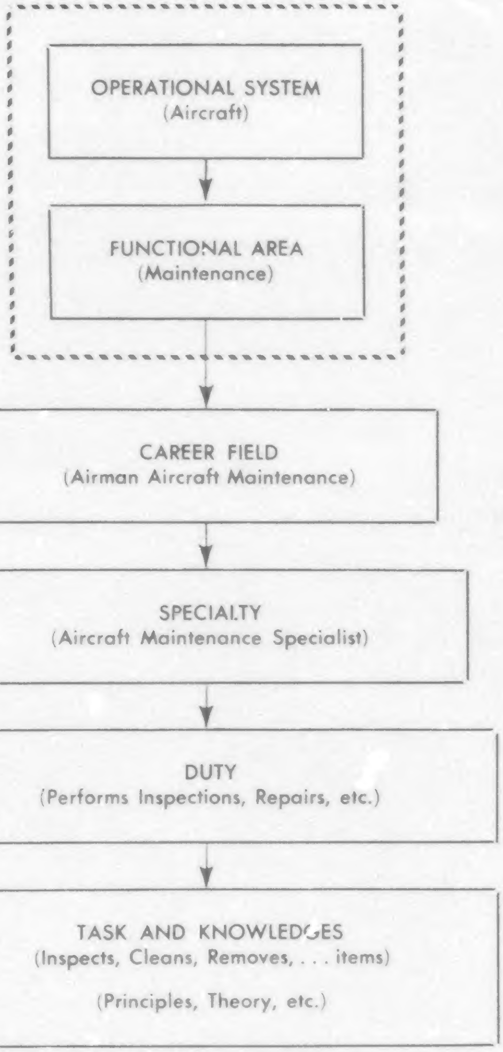
OPERATIONAL SYSTEM
(Aircraft)
FUNCTIONAL AREA
(Maintenance)
CAREER FIELD
(Airman Aircraft Maintenance)
SPECIALTY
(Aircraft Maintenance Specialist)
DUTY
(Performs Inspections, Repairs, etc.)
TASK AND KNOWLEDGES
(Inspects, Cleans, Removes, . . . items)
(Principles, Theory, etc.)

Figure 9-1. Sequence of Identification and Analysis

existing specialty, in which case it may be necessary to propose changes to an existing specialty or creation of a new one.

(4) After the career fields and Air Force specialties involved are determined, the process of identifying the specific duties and tasks and job supporting data continues. The basic methods for collecting the required information were explained in chapter 2. One of the most comprehensive sources of job data for an existing Air Force specialty is the Occupational Survey Report developed according to AFM 35-2, *Occupational Analysis Procedures for Conducting Occupational Surveys and Air Force Specialty Evaluation*. These reports are produced by the Air Force Occupational Measurement Center at Lackland AFB, TX.

(5) An occupational survey report is published after inventories have been administered to job incumbents and the data have been key-

Introduction

AIRMAN AIRCRAFT ACCESSORY MAINTENANCE CAREER FIELD (42)

The Airman Aircraft Accessory Maintenance Career Field includes the skills, functions, and techniques employed in the maintenance of propellers, pneudraulic systems, instruments, electrical systems, aircrew egress systems fuel systems, including inflight refueling systems, and other accessory systems normally installed in aircraft weapon systems. Accessory systems include pneumatic, oxygen, heating, cooling, fire extinguishing, pressurization, and fuel/air turbine auxiliary test systems. This career field also identifies the specialized skills required in the maintenance of aerospace ground equipment used in direct support of aircraft weapon systems.

Introduction

AIRMAN AIRCRAFT MAINTENANCE CAREER FIELD (43)

1. The Airman Aircraft Maintenance Career Field encompasses the mechanical functions of aircraft engine installation, removal, maintenance, and repair; and the maintenance, repair, and modification of helicopters, turboprop aircraft, reciprocating aircraft, and jet aircraft.

2. The Aircraft Jet Engine subdivision (AFSCs 432XO) includes installation, removal, maintenance, and repair of turbojet and ramjet engines when installed on missile systems such as the MGM-13, ADM-20, and the AGM-28. Also included in this subdivision is the maintenance responsibility for small fuel/air turbine auxiliary engines installed on aircraft weapon systems.

Introduction

AIRMAN METALWORKING CAREER FIELD (53)

1. The Airman Metalworking Career Field includes the functions involved in fabricating, molding, shaping, cutting, and joining metals, and repairing metal parts. This field includes aircraft structural repairs, metal heat treating, welding, plating, forging, and machining; and installation, modification, and formation of plastic articles. It also includes corrosion control for missile, aircraft, and support systems; and technical nondestructive inspection of aerospace material parts, components, and pressurized systems.

2. Excluded from this career field is the corrosion control function associated with Civil Engineering areas of responsibility which is included in AFS Protective Coater, AFSC 552X4.

Figure 9-2. Career Fields in Maintenance Function Evaluation

punched and computer analyzed. A single comprehensive report is prepared for the entire survey sample. However, separate reports can be made available for describing particular job types, specialties, shredouts, or organizational units.

(6) Figure 9-3 illustrates entries extracted from an actual occupational survey report compiled for the 431X1 career ladder. These extracts show the percent of time spent and the percent of members performing several tasks. The task, "Inspect and Service Liquid Oxygen Systems" is included five times to show differences based on aircraft type and AFS skill level. In figure 9-3, a comparison of the 3-skill level personnel shows that only 6.32 percent of the apprentice reciprocating engine aircraft mechanics perform this task, while 37.58 percent of the apprentice jet aircraft mechanics perform it. The figure also shows that the percent of members performing this task increases as they go from the 3- to the 5- to the 7-skill level, but the percent of the members' time spent on this task decreases as they go from the 3- to the 5- to the 7-skill level. If the ISD process establishes that instruction is required on this task, this information has implications for the design of the instruction.

(7) A study of the entire report reveals that a large number of aircraft maintenance specialists perform this task. This serves to validate the corresponding portion of the specialty description (see marked task in figure 9-4). Similarly, other statements in the specialty description are either validated, or a need for revision is indicated.

(8) Once the job performance requirements have been established, they are used in establishing, revising, or validating career field descriptions, specialty descriptions, training standards, and instructional systems.

9-3. Define Training Requirements:

a. METHODS FOR PROVIDING TRAINING. The accomplishment of Step 2 of the ISD model requires the identification of specific training requirements and the selection of methods for providing training. As explained in chapter 3 of this manual, one of the first actions in Step 2 of the ISD process is to determine if training is required. When a decision is made to provide training, the next action is to select the most cost-effective method or methods. In some situations, a single method such as OJT may be completely satisfactory. However, more typically, a combination of methods such as formal resident training, field training, and OJT is needed to meet initial and continuing training requirements for both new and existing operational systems. In each case the selection is based on factors included in the paragraph "CRITERIA AND CONSTRAINTS AFFECTING THE SELECTION OF METHODS," of chapter 3. When applying these factors, consideration should also be given to the following available methods of providing training:

(1) Contract Special Training (Type 1)[2] and Contract Technical Training (Type 6) are formal training conducted by civilian industrial or educational institutions. This method of providing training is often used to meet initial training requirements of new Air Force systems. Also, contract training is used when it is more economical than developing an Air Force training capability. An example of the latter is the Weather Officer Training Program which is provided by a civilian educational institution under contract with the Air Force.

(2) ATC Special Training (Type 2)[2] is formal training of a one-time or limited nature conducted by ATC instructors at an Air Force base or a contractor's location. It is designed to qualify experienced personnel in the operation and maintenance of weapon, equipment, or space systems and related equipment, or in operational techniques and procedures.

(3) Resident Regular Training (Type 3)[2] is formal training of a continuing nature conducted at an ATC installation. It includes courses designed for initial training of personnel, cross-training from one AFS to another, training on special or new equipment or procedures, and advancement within an AFS.

(4) Field Training (Type 4)[2] is training conducted by ATC personnel at operational locations on specific systems and associated direct-support equipment for maintenance and aircrew personnel. The training may be conducted by

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[2] See AFM 50-5, Volume I, chapter 3, 1 September 1974.

Description of current job in aircraft maintenance career ladder based on background variables. Shows percent members performing and percent time spent on tasks. Tasks are sorted high to low percent time spent by group members.

Task job description, Cases=9233, Tasks=362, Duties=14, MBRS=9232
All airmen in Crr Field DAFSC 431X1X/91 TOTAL SAMPLE

D-Tsk		Duty/Task Title	Percent of members performing	Average percent time spent by members performing	Average percent time spent by all members	Cumulative sum of average percent time spent by all members
F	16	Inspect Aircraft for Structural Damage	72.89	1.60	1.17	1.17
F	17	Inspect Airframe and Components	70.82	1.60	1.13	2.30
M	2	Defuel or Refuel Aircraft	68.08	1.64	1.12	3.41
G	9	Launch and Recover Aircraft	62.31	1.66	1.03	7.69
I	8	Inspect and Service Liquid Oxygen Systems	42.67	1.25	0.53	42.78

Task job description, Cases=9233, Tasks=362, Duties=14, MBRS=174
DAFSC 43131A App Reciprocating Engine Aircraft

I	8	Inspect and Service Liquid Oxygen Systems	6.32	2.24	0.14	91.91

Task job description, Cases=9233, Tasks=362, Duties=14, MBRS=314
DAFSC 43131E App Jet Aircraft Over Two Engines

I	8	Inspect and Service Liquid Oxygen Systems	37.58	1.87	0.70	55.98

Task job description, Cases=9233, Tasks=362, Duties=14, MBRS=1607
DAFSC 43151E Jet Aircraft Over Two Engines Specialist

I	8	Inspect and Service Liquid Oxygen Systems	47.92	1.22	0.59	47.44

Task job description, Cases=9233, Tasks=362, Duties=14, MBRS=672
DAFSC 43171E Jet Aircraft Over Two Engines Technician

I	8	Inspect and Service Liquid Oxygen Systems	54.17	0.85	0.46	51.79

3-, 5-, and 7-skill levels

Figure 9-3. Extracts from Occupational Survey Report

AFSC 43151*
Semiskilled AFSC 43151*

AIRMAN AIR FORCE SPECIALTY
AIRCRAFT MAINTENANCE SPECIALIST

1. SPECIALTY SUMMARY

Inspects, repairs, maintains, troubleshoots, services, and modifies aircraft and aircraft installed equipment; and performs crew chief and maintenance staff functions.

2. DUTIES AND RESPONSIBILITIES

a. *Performs inspections, functional checks, and preventive maintenance on aircraft and aircraft installed equipment:* Performs preflight, post-flight, and periodic/phase inspections of aircraft including structures, landing gear, engines, instruments, cockpits, cabins, flight surfaces, and controls. Inspects and performs functional checks of aircraft systems such as hydraulic, electrical, pressurization, lubrication, anti-icing, vacuum, induction and exhaust, and installed equipment such as external tanks, tow reels, hoists, and APUs. Inspects aircraft components for Cleanliness, alignment, proper clearance and operation, evidence of wear, cracks, and looseness in accordance with applicable technical orders. Launches and recovers aircraft. Inspects and inventories 780 equipment.

b. *Repairs, maintains, and services aircraft and aircraft installed equipment:* Removes, installs, or adjusts aircraft and aircraft system components such as control surfaces, wheels, brakes, tires, cowling, enclosures, hose, and tubing. Determines and accomplishes maintenance actions required to correct malfunctions indicated in aircraft forms and clears forms upon completion of maintenance. Cleans aircraft and engines. Identifies corrosion and applies protective measures. Troubleshoots malfunctions pertaining to aircraft structures, landing gear, control surfaces, induction, exhaust, ventilation and heating systems. Services oil, de-icing, fuel, hydraulic and oxygen (gaseous and liquid) systems. Tows and parks aircraft and performs engine run-up. Obtains engine oil samples (SOAP). Operates ground power equipment. Operates and maintains nonpowered ground equipment. Performs operator maintenance on aircraft installed auxiliary power unit. Interprets diagrams and applicable publications and initiates technical order deficiency reports (AFTO Form 22). Completes maintenance data forms.

c. *Performs aircraft allied functions:* Inspects and loads tow targets aboard aircraft; assembles and disassembles glider type targets. Preflights target towing equipment and performs in-flight operator duties associated with launch and recovery of targets. Performs assigned maintenance in repair and reclamation of aircraft and the removal, repair, and installation of aircraft wheel and tire assemblies.

d. *Supervises aircraft maintenance personnel:* Assigns work and reviews completed work to insure compliance with applicable technical publications and local procedures. Instructs subordinates in maintenance of aircraft and aircraft installed equipment. Insures compliance with appropriate procedures prescribed by USAF management directives. Conducts on-the-job training.

3. SPECIALTY QUALIFICATIONS

a. *Knowledge:*

(1) Knowledge of electrical, hydraulic, and mechanical principles as applied to aircraft; concepts and application of AFM 66—1, Maintenance Management System; maintenance and data reporting; and use of diagrams and technical publications is mandatory. Possession of mandatory knowledge will be determined in accordance with AFM 35—1.

(2) Knowledge of supply procedures is desirable.

b. *Education:* Completion of high school with courses in physics, hydraulics, and electronics is desirable.

c. *Experience:*

(1) Experience in functions such as repair and maintenance of aircraft and related installed and ground support equipment is *mandatory*.

(2) Experience in functions such as performing or supervising aircraft inspections is desirable.

d. *Training:* Completion of a basic aircraft maintenance course is desirable.

e. *Other:*

(1) Normal color vision as defined in AFM 160—1 is *mandatory*.

(2) A minimum aptitude level of Mechanical 50 is *mandatory*.

Figure 9-4. An Airman Air Force Specialty Description

4. SPECIALTY DATA

a. *Grade Spread:*

Sergeant and staff sergeant	43151
Airman first class	43131

b. *Related D.O.T. Jobs:*

Airplane Mechanic	621.281
Tire and Tube Repairman	915.884
The Repairman	915.884

c. *Related DOD Occupational Subgroup:* 600

5. *SPECIALTY SHREDOUTS

Suffix	*Portion of AFS to Which Related*
A	Reciprocating Engine Aircraft
C	Jet Aircraft One and Two Engines
E	Jet Aircraft Over Two Engines
F	Turbo-Prop Aircraft

Figure 9-4. An Airman Air Force Specialty Description (Continued)

either a field training detachment (FTD) or by a mobile training team (MTT), depending on cost-effectiveness and practicality. The primary purpose of field training is to qualify personnel on new equipment, new techniques and procedures, to acquaint personnel with specific systems, and to maintain a given level of proficiency. Mobile training teams are normally used to satisfy special training requirements when training equipment is not available at the training center or when it is not desirable to send students to a training center. Training by mobile training teams is a joint effort wherein ATC provides instructors, training materials, and funds for the travel and per diem of instructors, and the using command provides the training equipment and facilities.

(5) Command or Other Government Agency Training (Type 5)[3] is special or regular formal training conducted for the USAF by the Army, Navy, DOD, or other government agencies, or Air Force agencies other than ATC. Recently, DOD has designated a number of career fields where one service is responsible for providing training for personnel of all services.

(6) On-the-Job Training is a combination of self-study and job proficiency development through experiences gained on the job. OJT is basically the responsibility of the using activity; however, the career development courses (CDCs) used for self-study are usually developed by the Air Training Command. A detailed explanation of the OJT programs for enlisted personnel is contained in AFM 50-23, *On-the-Job Training.*

(7) Two other alternatives that should be considered in selecting the method for providing training are the "home study" instructional package and job performance aids. Both alternatives are discussed in chapter 3.

b. LEARNING DIFFICULTY OF TASKS. In applying the ISD process to apprentice level training, when the learning difficulty of tasks is identified, the results should be used to assign or reassign one of the following three categories to the specialty or specialties involved:

(1) Category A is assigned to specialties in which all new airmen must attend formal technical training before assignment to duty in an operational unit. The specialty includes a high percent of tasks which cannot be learned effectively on-the-job. For example, most aircraft, electronics, and missile maintenance specialties are assigned to this category due to the learning difficulty of the tasks.

(2) Category B is assigned to specialties in which only some of the new airmen attend formal

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[3] See AFM 50-5, Volume I, chapter 3, 1 September 1974.

technical training before assignment to duty in an operational unit. The remaining personnel are qualified through on-the-job training after assignment to an operational unit. All tasks in these specialties can be learned through OJT; however, formal training is provided for new airmen being assigned to units located in remote areas or to other units where OJT is not feasible or desirable, and for other personnel to foster standardized task performance in operational units. Typical Category B specialties are administration and plumbing.

(3) Category C is assigned to specialties in which new airmen receive no formal technical training. All new airmen are qualified through OJT after assignment to an operational unit. Vehicle operators, physical conditioning specialists, and painters are all typical specialties currently assigned to Category C.

9-4. Description of Training Standards:

a. DOCUMENTING TRAINING REQUIREMENTS. After training requirements are determined, they are normally documented in a training standard. Examples of training standards currently in use are the Course Training Standard (CTS) and the Specialty Training Standard (STS). Sample pages from these standards are shown in figures 9-5 and 9-6.

b. USE OF TRAINING STANDARDS. Training standards do exactly what the title implies. They establish the standard for training—a standard in terms of job tasks, knowledges, and proficiency levels. Also, the training standards are a type of Air Force contract. They specify what the training activity has agreed to deliver to the using activity—individuals with the capability of performing specific duties and tasks at a specified level of proficiency.

c. SPECIALTY TRAINING STANDARDS (STS):

(1) The STS is an Air Force publication used to standardize and control the quality of individual training required to achieve the skills within an entire Air Force specialty. These skills are based on job performance requirements of using activities and documented in terms of tasks, knowledges, and proficiency codes. The tasks and knowledges listed in STSs correlate with, or expand on, the specialty description for the Air Force specialty. When it is determined that the duties, responsibilities, and specialty qualifications published in AFM 39-1, *Airman Classification Manual*, are inadequate (partially obsolete, incomplete, not clear, etc.), a tentative STS should be prepared to include tasks and knowledges which are essential to current operational requirements. The procedure for submitting such standards for approval is described in AFR 8-13.

(2) A sample page from an STS is shown in figure 9-5. The code levels used (proficiency code key scale values) are defined in a separate code key page (not shown). Code levels assigned to tasks and knowledges constitute firm commitments on CDC content and level of training provided in applicable ATC formal courses, so it is most important that they reflect the training requirements that were established in Step 2 of the ISD process. Because the STS serves multiple purposes, and the code key must be interpreted, it is more difficult to prepare an STS that accurately describes the training requirements than to prepare a CTS that does this. The phrasing of the task and knowledge statements, as well as the code levels used, must be selected most carefully.

(3) The coding in columns 2A, 3A, and 4A of the STS indicates the minimum proficiency recommended for each task or knowledge for qualification at the 3-, 5-, or 7-skill levels of the Air Force specialty. Column 2A also shows the proficiency to be attained in the apprentice-level course. Proficiency code for the minimum proficiency recommended for the 3-skill level AFSC and the proficiency attained in the course is the same except when dual codes are entered. When dual codes are entered, the second code shows the proficiency attained in the course. Task performance scale value (code 1, 2, 3, or 4) defines level of performance for a specific task statement. Task knowledge scale value (code a, b, c, or d) defines a level of knowledge for a specific task. Accordingly, code a, b, c, or d may be used alone or with a numerical value for a specific task statement. Subject knowledge scale value (code A, B, C, or D) defines a level of knowledge for a subject not directly related to any specific task, or for a subject common to several tasks. Accordingly, code A, B, C, or D is used alone rather than with a numerical scale value.

STS 546X0F

TASKS, KNOWLEDGES AND STUDY REFERENCES	PROFICIENCY LEVEL, PROGRESS RECORD AND CERTIFICATION								
	2. 3 Skill Level			3. 5 Skill Level			4. 7 Skill Level		
1.	A AFSC/Crs	B Date OJT Started	C Date Completed & Trainee's Supervisor's Initials	A AFSC	B Date OJT Started	C Date Completed & Trainee's Supervisor's Initials	A AFSC/Crs	B Date OJT Started	C Date Completed & Trainee's Supervisor's Initials
19. NITROGEN TUBE BANK TRAILER									
SR: TOs 00-25-223, 21M-LGM25C-1, 21M-LGM25C-2-12, 36A9-12-3-2									
a. Operation of tube bank trailer	B			C			C		
b. Connect and disconnect high-pressure hoses	2b			3c			4c		
c. Transfer gaseous nitrogen	2b			3c			4c		
20. MANUAL AND SAFETY VALVES									
SR: TOs 00-25-223, 35M14-2-41-2, 35M14-3-25-3, 35M14-3-26-3, 35M14-3-27-3, 35M14-3-44-3, 35M14-3-45-3, 35M14-5-147-3, 35M14-7-10-3, 35M14-7-16-3, 35M14-7-17-3									
a. Operation of manual, check, and safety valves	B			C			C		
b. Check manual, check, and safety valves for correct operation	2b			3c			4c		
c. Disassemble, inspect, and reassemble manual, check, and safety valves	2b			3c			4c		
d. Repair manual, check, and safety valves	2b/b			3c			4c		
e. Adjust safety valves for popping pressure and seal	2b/b			3c			4c		
21. PNEUMATIC OPERATED VALVES							NO ADVANCED COURSE		
SR: TOs 00-25-223, 33D9-78-10-1, 35M14-5-87-3, 35M14-5-88-3									
a. Operation of pneumatic operated valves	B			C			C		
b. Check pneumatic operated valves for correct operation	2b			3c			4c		
c. Disassemble, inspect, and reassemble pneumatic operated valves	2b			3c			4c		
d. Repair pneumatic operated valves	2b/b			3c			4c		
e. Adjust pneumatic operated valves	2b/b			3c			4c		
22. PRESSURE CONTROL VALVES									
SR: TOs 00-25-223, 35M14-4-17-3, 35M14-5-93-3									
a. Operation of pressure control valves	B			C			C		
b. Check pressure control valves for operation	2b			3c			4c		
c. Inspect and disassemble pressure control valves	2b			3c			4c		
d. Repair pressure control valves	2b/b			3c			4c		
e. Adjust pressure control valves	2b/b			3c			4c		

Figure 9-5. Sample Page from a Specialty Training Standard (STS)

	Task, Knowledge and Proficiency Level	
1.	CONSTRUCTION FEATURES AND OPERATING PRINCIPLES OF WHITE DIESEL ENGINE	
a.	The design features of model 40SX-6 engine	B
b.	Operating principles of diesel engines	B
c.	Importance of optimum engine performance, and factors affecting engine power output	C
d.	Locate and identify engine and system components	4c
e.	Arrangement and operation of engine system components	B
2.	ENGINE LUBRICATION SYSTEM COMPONENTS	
a.	Clean and replace oil filters and strainers	3c
b.	Check oil for dilution, cleanliness, and proper grade	3c
c.	Inspect system for leakage	3c
d.	Adjust oil pressure regulating valves	3c
e.	Service engine oil system	3c
3.	ENGINE AIR INTAKE AND EXHAUST SYSTEMS	
a.	Cleaning and servicing of air cleaners, filters, breathers, and strainers	B
b.	Inspect turbochargers for operating condition and oil seals for leakage	3c
c.	Inspect and maintain intake and exhaust silencers and ducts	3c
d.	Inspect system for leakage and general condition	3c
4.	ENGINE AIR STARTING SYSTEMS	
a.	Inspect and service air compressor systems	3c
b.	Inspect, clean, and adjust engine air starting components	3c

Figure 9-6. Sample Page from a Course Training Standard (CTS) for Technical Training

d. COURSE TRAINING STANDARD (CTS):

(1) Course training standards are used to document the training requirements for a specific course of instruction. Typically, the tasks and knowledges contained in a CTS reflect unique training requirements for a specific weapon or support system rather than for a specialty. For example, a field training detachment responsible for developing a course for aircraft maintenance specialists and technicians in support of the C-141 aircraft would prepare a CTS containing only those tasks and knowledges needed for that aircraft. In another case, the CTS for missile launch officers for the LGM-25 ballistic missile program would include only those tasks and knowledges required for that weapon system. Although in both cases the training standards are based on training requirements that relate to job performance requirements, there still is a need to coordinate the training standards with the using command(s). One reason is that (for a career field course) the data obtained during Step 1 reflect conditions as of when the data were obtained. However, the using command(s) may have a requirement to change ongoing practices. The coordination will provide the opportunity to change the training standard to reflect *tomorrow's* needs. Even with training standards for new weapon/support systems, there still may be some constraints the using command(s) must live with which are not compatible with the version of the training standard sent out for coordination.

(2) Figure 9-6 shows a sample page from a CTS for technical training. This standard uses the same code key as the STS. It is also possible to develop a CTS in which only statements are used to describe the tasks, knowledges, and proficiency levels. For an example of such a standard, see figure 8-2.

9-5. Summary. As with other areas of application of ISD, the application to the design and development of technical training involves some special problems and special documentation. Most of what is "different" about applying the ISD process to technical training relates to its being Air Force specialty oriented, and affects primarily Steps 1 and 2 of the model. So, this chapter has dealt in more detail with the occupational survey, Air Force specialty descriptions, the alternative methods for providing training, the categorization of Air Force specialties with respect to method of apprentice-level training, and the training standard.

BY ORDER OF THE SECRETARY OF THE AIR FORCE

OFFICIAL

DAVID C. JONES, *General, USAF*
Chief of Staff

JAMES J. SHEPARD, *Colonel, USAF*
Director of Administration

Summary of Revised, Deleted, or Added Material

This revision significantly changes the first six chapters of the manual. The term "enabling" in relation to objectives is dropped, and "enabling objective test" has been renamed "diagnostic test." Guidance is expanded on selection of instructional methods, and there is a different approach to media selection. "Explanation of Terms" is expanded and made an attachment, and the bibliography is expanded and updated. To facilitate the application of ISD to the full spectrum of education and training, three new chapters have been added: Chapter 7, "Application of ISD to Knowledges and Attitudes"; Chapter 8, "Air Force Flying Training"; and Chapter 9, "Air Force Technical Training."

ATTACHMENT 1

EXPLANATION OF TERMS

Action——(See Response.)

Algorithm——An orderly procedure or exact prescription for solving a problem. In an algorithm, the physical layout of the presentation shows the relationship between input data, rules, and outcomes. Algorithms replace continuous prose as an instrument for communicating complex rules and regulations. (Figures 1-2 through 1-6, AFP 50-58, Volume I, 15 July 1973, are algorithms.)

Aptitude Test——A test or battery of tests designed to show a person's capacity for a particular type of behavior in a single field or in several related fields.

Association——The connection made between an input (stimulus) and an action (response). For example, a person responds with the letter "A" when hearing the code "dih-dah."

Automated Apprenticeship Training (AAT)——A training approach in which the trainee receives tutorial guidance through pictures with accompanying sound when provided opportunity to practice. Trainee performance is evaluated by peer or instructor.

Behavior——Any activity, overt or covert, capable of being measured.

Behavioral Objective——A statement that specifies precisely what behavior is to be exhibited, the conditions under which behavior will be accomplished, and the minimum standard of acceptable performance.

Carrel (Learning)——A study cubicle designed for use by one or a small number of students. Carrels usually contain audiovisual media for presentation of programmed audiovisual instruction.

Chaining——The linking together of a series of discriminable responses in a particular order. The completion of each response provides the stimulus for the next response. May involve chains or verbal responses (reciting a list of numbers) or chains of motor responses (following a procedure). (See also Association and Discrimination.)

Computer-Assisted Instruction (CAI)——An instructional method whereby students interact (usually) individually to instruction presented through a variety of media, usually computer controlled or monitored. The student can respond to the stimuli in a variety of ways, such as with a keyset or pointing device. He is immediately informed as to the accuracy of his response. The computer uses algorithms to diagnose his response to determine the probable reason for any errors, and to present additional instruction in accordance with the diagnosis.

Computer Directed Training System (CDTS)——A training system that involves dependent subsystems (functional software and courseware) and related documentation. Functional software enables use of hardware by the course designer to code course material and by the student to interact with courseware. Courseware is the subject matter and instructional data in whatever media required by the student to complete his course through use of a computer terminal. (See also Computer-Assisted Instruction and Computer-Managed Instruction.)

Computer-Managed Instruction (CMI)——In CAI the student interacts directly with instruction presented by computer controlled or monitored equipment. In CMI, the student does not necessarily interact directly with the equipment, though he may be "online" for testing, diagnosis, and prescription. The role of the computer in CMI is to aid the instructor in managing the instructional program.

Confirmation——Notification to the student of the correctness of his response. (See also Feedback and Knowledge of Results.)

Constraints——Limiting or restraining conditions or factors, such as policy considerations, time limitations, environmental factors, and budgetary and other resource limitations.

Cost-Effectiveness——A comparative evaluation derived from analyses of alternatives (actions, methods, approaches, equipment, weapon systems, support systems, force combinations, etc.) in terms of the interrelated influences of cost and effectiveness in accomplishing a specific mission or objective.

Course Control Documents——Specialized publications used to control the quality of instruction. Specialty training standard, course training standard, plan of instruction, syllabus, and course chart are course control documents.

Courseware——The technical data, textual materials, and audiotapes, slides, movies, TV cassettes, and other audiovisual instructional materials. (See also Hardware and Software.)

Criterion-Referenced Test (CRT)——Test to determine if behavior as specified in objectives has been acquired. During instructional system development, the CRT can be used to measure the effectiveness of the instructional system. May involve multiple-choice items, fill-in items, essays, or actual performance of a task. If given immediately after learning sequences, it is a test of acquisition; if given considerably later, it is a retention test; if it requires performance not specifically learned during instruction, it is a transfer test.

Decision Logic Chart/Table——Guide to assist in the decision-making process. Represents the inputs likely to occur for a given situation and recommends a course of action or, if appropriate, alternative actions. Also called Decision Table.

Discrimination——Making different responses to the different stimuli. A discrimination requires a person to determine the differences among inputs and to respond differently to each.

Distributed Practice——During learning, the process of spacing numerous, relatively short, practice sessions throughout the learning period. (See also Massed Practice.)

Duty——A large segment of the work done by an individual. The italicized paragraph headings in the duties and responsibilities section of the specialty descriptions in AFMs 36-1 and 39-1 set forth the major duties performed in each AFSC.

Enrichment——Supplementary material which aids the student in progressing through the course but is not considered crucial to learning.

Feedback——Information which results from or is contingent upon an action. The feedback does not necessarily indicate the rightness of an action. Rather it relates the results of the action from which inferences about correctness can be drawn. Feedback may be immediate, as when a fuse blows because a lamp was incorrectly wired, or delayed, as when an instructor provides a discussion pertaining to an exam taken the previous week, or when completed graduate evaluation questionnaires are reviewed. (See also Knowledge of Results and Confirmation.)

Field Test——Tryout of any training course on a representative sample of the target population to gather data on the effectiveness of instruction in regard to error rates, criterion test performance, and time to complete the course.

Full Mission Simulator——A device that allows simulation of major tasks related to *all* crewmembers for a given aircraft-mission combination. It has the capability of simulating environmental conditions necessary for mission performance, including, but not limited to, motion and visual systems, flight characteristics, full instrumentation of sensors necessary to the mission, and simulation of environmental stimuli for their activation. A fully dynamic system.

Generalization——Learning to respond to a new stimulus similar, but not identical, to one that was present during original learning; for example, during learning a child calls a beagle and spaniel by the term "dog." A child who has generalized would respond "dog" when presented with hound as a stimulus.

Group-Pacing——A procedure in which students progress together toward the same objectives; often employed where self-pacing is not practical for administrative reasons. Also called Lockstep. (See also Self-Pacing.)

Hardware——The physical components of a system (usually electronic or electrical devices) which are utilized in educational processes including computers, terminals, audiovisual devices, teaching machines, etc. (See also Courseware and Software.)

Input——(See Stimulus.)

Instructional Objective——(See Objective.)

Instructional Media—The means used to present information to the student.

Instructional System——An integrated combination of resources (students, instructors, materials, equipment, and facilities), techniques, and procedures performing efficiently the functions required to achieve specified learning objectives.

Instructional System Development (ISD)——A deliberate and orderly process for planning and developing instructional programs which ensure that personnel are taught the knowledges, skills, and attitudes essential for successful job performance. Depends on a description and analysis of the tasks necessary for performing the job, objectives, and tests clearly stated before instruction begins, evaluation procedures to determine whether or not the objectives have been reached, and methods for revising the process based on empirical data.

Instructor Guide——A publication designed to provide the administrator of instructional materials with information about the objectives of the materials, the procedures involved in their development, suggestions for their optimal use, and descriptions of what might be expected from the materials based on their previous effectiveness.

Job——The composite of duties and tasks actually performed by an individual.

Job Inventory——An instrument used for conducting an occupational survey. It consists of items for identification and background information, and a list of appropriate duty and task statement. The job inventory does *not* include standards of performance for the duties and tasks listed.

Job Performance Aid (JPA)——A device, book, chart, or other reference which facilitates the job performance by reducing the amount of information the human performer must recall or retain in order to successfully carry out a task. The guidelines on a movie projector showing the path for threading the film is a job performance aid for the projectionist.

Job Performance Requirements (JPR)——The tasks required of the human component of a system, the conditions under which these tasks must be performed, and the quality standards for acceptable performance. JPRs describe what people must do to perform their jobs.

Knowledge of Results——A report to the student on the correctness of the response. It may be a verbal report of right or wrong or a display (verbal or visual) of the correct response. (See also Confirmation and Feedback.)

Knowledges——Knowledges are not directly observable. They involve the use of mental processes which enable a person to recall facts, identify concepts, apply rules or principles, solve problems, think creatively, etc. A person manifests knowledge through performing associated overt activities. (See also Skills.)

Learner-Centered Instruction (LCI)——An instructional process in which the content is determined by the learners' needs, the instructional materials are geared to the learners' abilities, and the instructional design makes the learners active participants. The instructional system development process produces learner-centered instruction.

Learner-Controlled Instruction——An instructional environment in which the student can choose from a variety of instructional options for achievement of the terminal objectives. Students can vary their rate of learning, the media used, etc.

Learning——A change in the behavior of the learner as a result of experience. The behavior can be physical and overt, or it can be intellectual or attitudinal.

Learning Center——A learning environment which has been specifically developed to foster individualized instruction and which emphasizes employment of media to augment textbooks and manuals.

Massed Practice——During learning, the process of providing all practice sessions at a specific point in the learning period (usually at the end of instruction). This is generally considered inferior to distributed practice. (See also Distributed Practice.)

Measurement, Criterion-Referenced——The process of determining, as objectively as possible, a student's achievement in relation to a fixed standard which is based on criterion objectives.

Measurement, Norm-Referenced——The process of determining a student's achievement in relation to other students. Grading "on the curve" involves norm-reference measurement since an individual's position on the curve (grade) depends on the performance of other students. Generally, norm-referenced measurement is not appropriate in ISD.

Medium (plural, Media)——A means of effecting or conveying something. Medium is a general term roughly comparable in many ways with tool, instrument, vehicle, means, etc.

Modular Scheduling——A course is divided into small units of instruction called modules. Each module supports one or more training objectives. Students are pretested and counseled on objectives to determine which modules of instruction they require. Students receive only those modules that pretesting and counseling indicate they need.

Multimedia Approach——The correlated use of more than one type of instructional medium as a vehicle for presenting the instructional materials. Characteristically, an instructional package which employs a multimedia approach may use textbooks, films, slides, etc., to present various segments of the entire package.

Multitrack Course——A course which employs more than one track or channel of instruction. Course goals are the same on all channels, but course content, degree of instruction, and presentation all vary to accommodate students of different aptitudes and levels of previously acquired skills and knowledges.

Objective——Objectives specify precisely what behavior is to be exhibited, the conditions under which the behavior will be accomplished, and the minimum standard of acceptable performance.

Occupational Survey——The Air Force procedure for the identification of the duties and tasks which comprise one or more shred-outs, prefixes, specialties, career field ladders, or utilization fields; and for the collection, collation, and analysis of information concerning such duties and tasks.

Part-Task Practice——An exercise, performed with or without a training device, which allows students to practice some portion of a task or set of tasks. (See also Whole-Task Practice.)

Part-Task Trainer——A system that provides dynamic simulation of some subset of mission requirements. The subset may be defined in terms of crew positions and/or mission segments. It will include only those capabilities necessary for dynamic simulation of the tasks for which it is designed. Instrument flight simulators and aerial refueling part-task trainers both fit this definition.

Peer Training——A method of instruction in which a student who has completed training acts as an instructor to another student in the skill or process to be learned. This procedure continues with each trainee becoming an instructor for the next trainee.

Perception——The process of information extraction. The process by which a student receives or extracts information from the environment through experiences and assimilates this data as facts (sight, sound, feel, taste, smell).

Performance——The carrying out of an act to completion; actual accomplishment of a task to some preset standard of completeness and accuracy.

Performance Measurement——The process of determining if the student's performance on a given task reaches the standard for that specific tasks.

Plan of Instruction (POI)——A qualitative course control document designed for use primarily within an Air Force school for course planning, organization, and operation. Generally, for every block of instruction within a course, criterion objectives, duration of instruction, and support materials/guidance factors are listed (also called a Syllabus).

Position——The duties and tasks established as the work requirement for one individual. A position exists whether occupied or vacant.

Posttest——A test given to a student upon completion of a course of instruction to measure learning achieved.

Pretest——A test given to a student prior to entry into a course or unit of instruction to determine the technical skills and knowledges (entering behavior) he possesses in a given subject. Can be used to identify portions of the instruction the student can bypass.

Procedures Trainer——A nondynamic system that allows procedural training to be accomplished. It could take the form of a mockup or a cockpit procedures trainer.

Programmed Instruction——A student-centered method of instruction which presents the information in planned steps or increments, with the appropriate response immediately following each step. The student is guided step-by-step to the successful completion of the assigned task or training exercise.

Programmed Instructional Material——Instructional material, such as texts, tapes, films and filmstrips, slides, scripts for live presentations, etc., prepared specifically to employ techniques of programming.

Response——Any activity which is induced by a stimulus. In instruction, it designates a wide variety of behaviors which may involve a single word, selection among alternatives (multiple choice), the solution of a complex system, the manipulation of buttons or keys, etc.

Response, Covert——An internalized response which the student presumably makes but which is neither recorded nor otherwise available to an observer (for example, a student "thinks" a response).

Response Mode——The manner in which a student responds, for example, writing a sentence, selecting an answer from a group of choices, repairing a piece of equipment, etc.

Response, Overt——A student's oral, written, or manipulative act which is, or can be, recorded by an observer.

Self-Pacing——A procedure in which students can progress through an instructional program at their own rate. (See also Group-Pacing.)

Shaping——A technique which reinforces successive approximations, starting with behavior that is already present (for example, questions the student can answer already). Gradually, more difficult material is presented and more sophisticated answers are required.

Simulation——A technique whereby "job-world" phenomena are mimicked, in an often low fidelity situation, in which costs may be reduced, potential dangers eliminated, and time compressed. The simulation may focus on a small subset of the features of the actual job-world situation.

Simulator——A generic term including full mission simulators, part-task trainers, procedures trainers, etc. Simulator and simulator training device may be used interchangeably.

Skills——Skills involve physical or manipulative activities. They often require knowledges for their execution. All skills are actions having special requirements for speed, accuracy, or coordination. (See also Knowledges.)

Software——The programs and routines used to extend the capability of automatic data processing equipment. (See also Courseware and Hardware.)

Stimulus——The event, situation, condition, signal, or cue to which a response must be made.

Subject Matter Specialist——A person who has thorough knowledge of the material being programmed. He acts as advisor and critic concerning subject matter during the production of programmed materials.

Subsystem——A major functional subassembly or grouping of items or equipment which is essential to the operational completeness of a system.

Survey Test——The survey test is a criterion-referenced test used prior to the development of an instructional system. It is administered to a sample of prospective students to determine what skills and knowledges should be put into the course of instruction.

System——The composite of equipment, skills, techniques (includes all related facilities, equipment, materials, services, and personnel) that is capable of performing and/or supporting an operational role.

Systems Approach to Training——(See Instructional System Development (ISD).)

Target Population——The persons for whom the instructional or training materials are designed. Samples from this population are used in evaluating instructional materials during their development.

Task——A unit of work activity or operation which forms a significant part of a duty. It constitutes a logical and necessary step in a performance, and usually has a logical beginning and end. (Task statements may be found under duties listed in AFMs 36-1 and 39-1.)

Task Analysis——As used in the handbook, includes the process of describing job tasks in terms of JPRs and the process of analyzing these JPRs to determine TRs. (See also Job Performance Requirements (JPR) and Training Requirements (TRs).)

Threshold Knowledge Test (TKT)—(See Survey Test.)

Trainer——A job performance oriented device designed to simulate conditions inherent in the equipment which it represents.

Training Aid——Any item which is developed and/or procured with the primary intent that it shall assist in training and the process of learning.

Training Requirements (TRs)——TRs are those skills and knowledges which are required for satisfying the job performance requirements, and not already in the students' incoming repertoire.

Transfer of Training——Ability of the learner to apply old (familiar) concepts to new situations. Transfer of training is most effective when the learning situation is so organized as to facilitate generalization and the recognition of relationships.

Validation——The process of developmental testing, field testing, and revision of instruction to be certain that the instructional intent is achieved. The system is developed unit by unit and tested (or validated) on the basis of the objectives prepared for each unit. Validation allows instructional designers to guarantee specified results.

Whole-Task Practice——An exercise, performed with or without a training device, which allows students to practice an entire task at one time. (See also Part-Task Practice.)

ATTACHMENT 2

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NOTE: DOD activities can purchase documents identified with an "AD" number from Defense Documentation Center, Cameron Station, Alexandria, VA 22314. Others can purchase these documents from US Dept. of Commerce, National Technical Information Service, Springfield, VA 22151.

ATTACHMENT 3

Annotated Bibliography

There are numerous publications, both governmental and commercial, which will aid writers in developing and editing instructional materials. The following paragraphs present recommendations of several publications which can be useful in these endeavors.

GOVERNMENTAL PUBLICATIONS

Air Force Publication Management Program. AFM 5-1. Washington, DC: 1 October 1968. This manual, especially in chapters 7, 8, 9, and 15, pertains to all who prepare training literature. These chapters present the steps in developing and issuing a publication; how to prepare, review, and edit manuscripts; and how to initiate changes to publications.

Guide for Air Force Writing. AFP 13-2. Washington, DC: 1 Nov. 1973. This pamphlet provides one standard writing guide for all Air Force personnel who write or approve the writing of others. It covers the principles of clear, logical thinking and writing, with specific suggestions for applying these principles to Air Force written communications. One entire chapter is devoted to the preparation of publications. *NOTE:* The Directorate of Administration at each Air Force Base has the multimedia (slides, audiotape, student exercises, and instructor) Air Force Writing Course which correlates with AFP 13-2. This course was prepared through application of the ISD process.

COMMERCIAL PUBLICATIONS

A Program for Effective Writing. Robert L. Shurter and James M. Reid, Jr. New York: Appleton-Century-Crofts, Inc., 1966. This programmed text presents composition in terms of clarity, conciseness, force, appropriateness, and organization.

Harbrace College Handbook. John C. Hodges and others. New York: Harcourt, Brace and World, Inc., 1972. This book is one of the more convenient grammar and writing references. The front and back covers of the book contain information to identify the numerically-designated sections.

How to Write, Speak, and Think More Effectively. Rudolf Flesch. New York: Harper and Row Publishers, Inc., 1960. It includes material from five other books by Rudolf Flesch: *The Art of Plain Talk, The Art of Readable Writing, The Art of Clear Thinking, How to Test Readability,* and *A New Way to Better English.* The author's well-known Reading-Ease Chart is also included.

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ATTACHMENT 4

Bibliography of Technical Materials

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	APPLICABILITY							
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[1] Department of Defense activities may obtain reprints of this article in limited quantities from ATC/XPTT, Randolph AFB, TX 78148.

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Morsh, Joseph E. and Archer, Wayne B. *Procedural Guide for Conducting Occupational Surveys in the United States Air Force* (Technical Report 67-11). Lackland AFB, TX: Personnel Research Laboratory, Air Force Systems Command, September 1967 (AD-664 036).							X	
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NOTE: DOD activities can purchase documents identified with an "AD" number from Defense Documentation Center, Cameron Station, Alexandria, VA 22314. Others can purchase these documents from US Dept of Commerce, National Technical Information Service, Springfield, VA 22151.								

FILM SERIES

The Air Force is developing a 16mm film series on "Instructional Technology: The State-of-the-Art." The first five films in this series are:

TF6700, "Instructional Systems Development: The Process" (27 min).

TF6701, "Criterion Objectives: The Key to Success" (16 min).

TF6702, "Criterion-Referenced Testing" (19 min)

TF6703, "Individualized Instruction" (19 min)

TF6704, "The Changing Role of the Instructor" (11 min)

These films are available for free loan from audiovisual libraries located at most Air Force bases. Organizations not within convenient distance of an Air Force base for local over-the-counter film service should contact USAF Central Audiovisual Library, Audiovisual Service, Norton AFB, CA 92409, for ordering instructions and request forms.

ATTACHMENT 5

Instructions for Completing the ISD Status Report

ISD Status Report, RCS: HAF-DPP(SA)7303: Outline of Data Required

The following is an outline of exemplary data which the report is intended to provide. The report content may vary somewhat for different commands. (Coordinate specific report content for each command with AF/DPPTB).

A—ISD Projects:

1. *Course*—Identify all projects listed by course number and title.

2. *Start Date*—Indicate the date the ISD effort began.

B—Percent Complete (Steps):

1. Indicate the percentage of completion of each applicable step of the ISD model.

2. If the project was terminated at any point prior to implementation, indicate the percentage of completion that was attained in each applicable step and briefly state the reason for termination in the remarks section.

C—Implementation Date:

Indicate the date the course was implemented or range of time (beginning and ending dates of implementation) over which implementation will occur.

D—Course Length:

Give information indicating the effect on course length. For example, the before and after course lengths, where the "before" figure is the total number of training days and/or flying hours as applicable, of the project indicated in section A prior to application of ISD. The "after" figure will reflect any change in hours after implementation of the project. If the project is terminated, enter final course length.

E—Student Flow:

Provide information which quantitatively describes the student flow. For example, show student flow for the project/course identified in Section A. Provide in terms of student flow for a specific time period (200/yr, 30/wk) using the most current information available.

F—Remarks:

Use the remarks section to provide amplification or clarification of any of the preceding sections or any additional information considered relevant.